THE JOURNAL OF
PROSTHETIC
DENTISTRY

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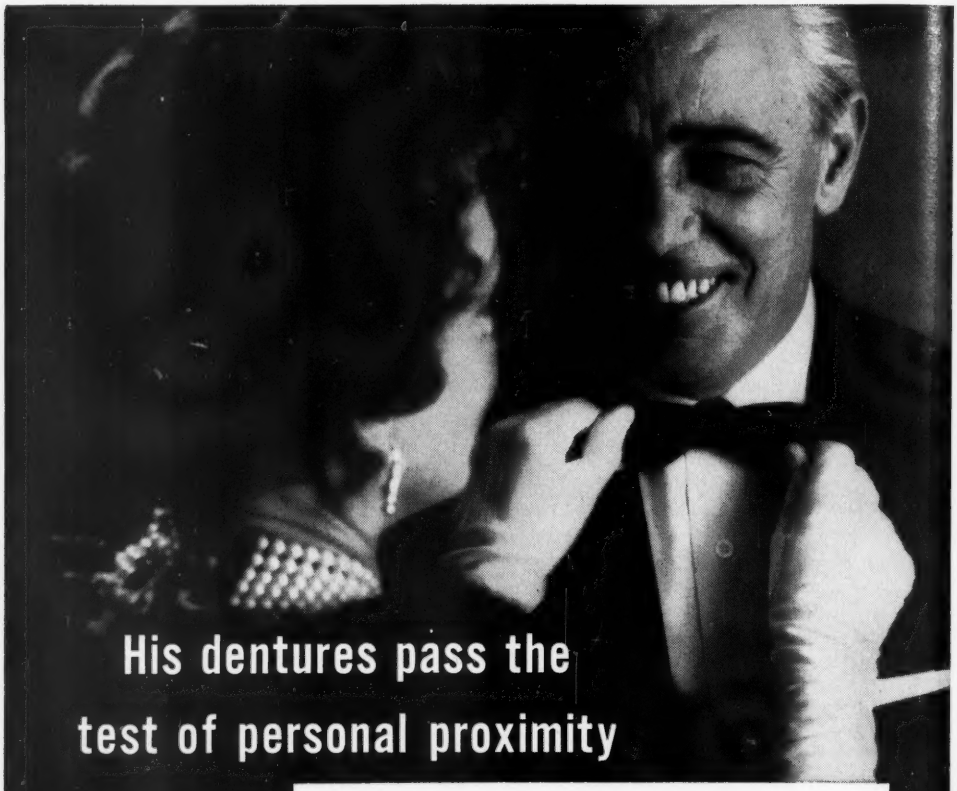

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Implant Dentures: Surgical—Unfavorable—Qualified.
W. Harry Archer, B.S., M.A., D.D.S., University of Pittsburgh, School of Dentistry, Pittsburgh, Pa. **1127**
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Vol. 10, No. 6, November-December, 1960. The Journal of Prosthetic Dentistry is published by the C. V. Mosby Company, 3207 Washington Blvd., St. Louis 3, Mo. Subscription rates: United States and Its Possessions $12.00; Canada, Latin-America, and Spain $12.50; Other Countries $13.00. Special rates for dental students and dentists on residency programs, one-half of the domestic rate; for students in other countries, one-half of the domestic rate plus the full amount of the applicable charge for international postage. Single copies, $2.50 postpaid. Second class postage paid at St. Louis, Mo., and at additional offices. Printed in the U.S.A. Copyright © 1960 by the C. V. Mosby Co

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1960
VOLUME 10
NUMBER 6

THROUGH THE EYES OF THE EDITOR

Chester Perry discusses the examination, diagnosis, and treatment planning for complete denture patients. This is one of the most important phases of denture construction. Failure to carry out these procedures in relation to the patient as a whole will result in inadequate denture service and expose the patient to grave dangers to his health, comfort, and happiness. The discussion points out the essential steps in preparing patients for dentures in an orderly and logical sequence. An appreciation for the application of the basic sciences to the problems of complete denture service is apparent in this article.

Bernard A. Sussman discusses the variations in techniques for making complete dentures and describes his basic technique. He points out the most critical phases of denture construction and suggests means for making certain that they are properly carried out. Not all denture patients will be adequately treated by "minimum" techniques.

Joseph S. Landa continues his discussion of trouble shooting in complete denture prosthesis. The various types of mucosal irritations and the means for making a differential diagnosis are described. It is obvious that the cause of the trouble must be recognized before the treatment can be effective. A careful application of knowledge of the related basic sciences is essential.

Victor H. Sears discusses the similarity and differences of occlusal balance as required for complete dentures and for occlusion of natural teeth. The effects of malocclusions vary in different situations. He points out these differences and yet suggests that dental schools should teach occlusion in an "autonomous department of dental occlusion." This seems to be inconsistent when the recognized variations in application of the principles of occlusion are considered.

Joseph George Naylor discusses the role of the external pterygoid muscles in the control of the temporomandibular joints. He suggests that they are the determining factors in mandibular movement, rather than the bony contours of the joints. This is at least partly true, since the fibrous tissue covering both the condyle and the fossa and the interarticular disk will modify the direction of the movement of the condyle from that indicated by the bones. However, his statement that the opening movement involves rotation about an "axis below the condyle" is true only under certain conditions. In normal uncontrolled wide opening movements, it is quite likely that this movement is a rotation centered *below* the condyle. This was suggested many years ago by Ruppert Hall and others who designed articulators with their opening axes level with the occlusal plane (Hall Automatic Articulator). In *controlled* movements with the mandible held in its most posterior position, the mandible can be made to rotate about an axis through the condyles. It is apparent that the author is dis-

cussing only the movements which occur in normal function.

Wilson W. Chase discusses the use of polysulfide rubber–base impression materials and the means for adapting them to various prosthodontic situations. He concludes that the materials are useful provided they are handled properly. Careless handling will produce inadequate results. This is a requirement with similar application to all other materials and techniques. There is no magic material.

A. H. Tamarin describes his technique for making anterior veneer crowns of gold and acrylic resin. The ingenious design of the backing provides resistance to abrasion and the forces of occlusion. The acrylic resin facing conceals almost all of the gold.

Milton Silver, George Klein, and Michael C. Howard discuss tests made of the porcelains and the metals used for restorations composed of porcelain baked on metal. They conclude that high-fusing porcelains and metals offer the best possibilities for success and that all phases of the technique require extreme care in their execution.

Frederick M. Liebman and Francisco Cosenza report their evaluation of electromyography in the study of the etiology of malocclusion. The observations were made of the electrical activity recorded from the masseter and temporal muscles of subjects with different types of occlusion. They conclude that several factors enter into the variations they noted and that other means for measurement must be correlated with electromyography to make sure the data are correctly interpreted.

Arthur S. Freese discusses the causes, symptoms, and diagnosis of temporomandibular joint pain. He classifies these pain symptoms according to their origin and lists the causes of muscle spasm related to temporomandibular joint disturbances. He recognizes the difficulty of interpretation of temporomandibular joint roentgenograms and compares the effectiveness of various techniques for making these roentgenograms. He concludes that clinical examination is the most reliable diagnostic method.

Louis J. Boucher reports his observations of arthrodial types of temporomandibular joints in experimental animals. On the basis of his experiments, he concludes that the external pterygoid muscles are responsible for stopping the posterior movement of condyles. This is a controversial subject, and one might wonder if muscle tissue alone could be so inelastic as to make needle point tracings with sharp apices possible.

Duncan McConnell and Richard G. Brawley, Jr., report on their tests of the compressive strength of a new silicate cement which is reinforced with impregnated glass fibers. Their results seem to indicate that the reinforcement weakens rather than strengthens the cement. They also report the development of a new type of mold for making test cylinders. This mold does not require a lubricant as others do.

Claude R. Baker discusses the condensation of the mix of porcelain before firing and suggests a means whereby the particles can be brought closer together. He describes his equipment and technique for condensing porcelain for various restorations. His device for holding facings during this process is ingenious and effective.

J. Eugene Ziegler and his committee report on biologic, physical, clinical, and mechanical research as it relates to the future of dentistry and point out new trends in dental education and methods of practice of dentistry. This is a broad coverage of many factors of interest to all dentists.

Edmundo Pinto da Fonseca describes two types of prosthetic appliances which were devised to assist plastic surgeons in the treatment of cicatricial deformities of the lips. The appliances serve to stretch the lips and counteract the closure caused by scar tissue.

Marshall W. Mueller provides the background and introduction for the panel which attempts to evaluate implant denture service on the basis of experiences during the past 10 years.

Allen G. Doner evaluates the surgical aspects of implant dentistry and considers the procedures to be satisfactory. This is provided, however, that *all* phases of the service, including diagnosis, design, surgical operation, prosthetic treatment, and postoperative care, are properly handled.

W. Harry Archer finds implant dentures to be not completely satisfactory; neither does he find this service totally unsatisfactory. He suggests that further research on the techniques used in implant dentistry is necessary.

Roy L. Bodine, Jr., discusses the favorable aspects of implant dentistry and rates this type of treatment as increasingly successful.

Carl O. Boucher discusses the unfavorable aspects of prosthetic treatment by means of implant dentures. He points out various de-

ficiencies of the service but emphasizes the fact that implant dentures are not recommended for the aged and ill patients who need them most. Further research *might* overcome the difficulties that exist today.

Melvin L. Moss reviews and compares the studies of mandibular growth and discusses various factors which influence the growth. He points out the relationship of mandibular growth to the treatment of certain malfunctions or deformities.

George J. Kienzle suggests that writing can be a tool to be used for research since it gives the research worker an opportunity to evaluate what he plans to do and thus avoid costly errors. He also points out its value to dental education and to the care of patients. Some techniques in dentistry are developed and used with *apparent* success. When they are described on paper, however, their weaknesses or inadequacies may become obvious. Writing can be helpful to both the writer and the reader.

Lorne E. MacLachlan describes his procedure and equipment for making duplicate color transparencies. The technique is simple and effective.

—Carl O. Boucher

COMPLETE DENTURES

EXAMINATION, DIAGNOSIS, AND TREATMENT PLANNING

CHESTER PERRY, D.D.S.*
University of Detroit, School of Dentistry, Detroit, Mich.

A PROSTHETIC EXAMINATION IS COMPLEX. It involves decisions about the teeth to be restored, extracted, or replaced. Also involved are oral conditions, including the muscles of facial expression and of jaw function as well as the posture muscles. A psychologic examination should be included as well. Preliminary findings must be based on a knowledge of the physiologic and pathologic condition of the oral structures as well as that of the general systemic mechanism.

Such an examination and diagnosis cannot be completed at the first appointment. At each subsequent appointment, however, more is learned about the patient's health, emotional status, and the expectations he has regarding dentures.

HISTORY

The patient's history, both medical and dental, should be complete. Most patients and dentists consider the history as a passive device which is employed as an adjunct to the completion of the dentures and as a necessary evil to be skimmed over haphazardly. The patient who is in good physical health and is emotionally stable possesses the attributes necessary to the wearing of dentures successfully. The requirement of a complete history for those patients may not be necessary. However, in most instances, the dentist cannot tell whether or not a patient is physically well and emotionally stable until a complete history is recorded. The diagnosis cannot be complete until we have completed the history of the patient.

EXAMINATION RECORD

At the first appointment, a short examination record should be made. The record card should contain entries to identify the patient (name, address, etc.), a record of any deviation from the normal, and an indication of conditions that

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Read before the American Denture Society in New York, N. Y.
*Assistant Professor of Denture Prosthesis.

might be improved. The record card should provide a listing of the recommended treatment as well as the results that are hoped for by undertaking such a program. Pertinent statements by the patient regarding his present condition, his thoughts on improvement of this condition, and whether or not he accepts the suggestions of the dentist should be listed.

The record card should contain detailed personal information such as the source of the reference, age, and occupation. The patient's appreciation of dentistry, particularly prosthetic dentistry, his expectations, and his desires are included.

The first appointment should be one of friendliness on the part of the dentist. Many patients express deep concern as to their ability to adjust to new dentures. If their present dentures have not been successful, they may be skeptical that new dentures may prove to be no better.

Many patients who are in need of prosthesis are fearful. The hands, especially the dorsa, may be edematous, the voice may give out because of edema of the larynx, there may be a sudden swelling of the lips, or there may be patchy swellings of the arms, legs, or neck. Such manifestations are angioneurotic edemas and are brought about by anxiety or fear. Many times, through kindness and friendliness to the patient and by creating a feeling of confidence on the part of the patient toward the dentist and the care he will receive, these manifestations will subside even while the patient is in the office. If they do not, the patient is dismissed and a sedative is prescribed to be taken a few hours prior to the next appointment. Tranquilizers may be used—Miltown* (not more than 4 per day), Equanil† (400 mg.), or the barbiturates such as Nembutal‡ or Seconal.§ At the following appointment, the patient will be relaxed and the examination can be completed easily. The cessation of the gag reflex has been accomplished by administration of Miltown 3 hours before the patient's dental appointment.

It is necessary to know why the patient wants new dentures. His reason may be better function, the relief of pain, improvement of appearance, prevention of disease, or improvement of health. We should attempt to satisfy the paramount desires of the patient insofar as is possible. If the patient is chronically ill and has a lowered general resistance, however, a new denture may only add to a discomfort of long standing. Many dentures must be made for patients who have psychologic problems or metabolic disorders which may be brought about by a lack of good nutrition or by hormonal imbalance.

Many older patients have cerebrovascular disease, Parkinson's disease, facial paralysis, cancer, or postural infirmities. Denture appearance is secondary to the best functional result for these patients.

The social life of the patient should be discussed, since his job and place in the community will determine the type of denture service to be rendered. So often a person of excellent social standing does not make a good denture patient psychologically. He may lack the capacity to adjust to life's difficulties, particularly when they are further complicated by the wearing of complete dentures.

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*Lederle Laboratories Division, American Cyanamid Co., Pearl River, N. Y.
†Wyeth Laboratories, Inc., Philadelphia, Pa.
‡Abbott Laboratories, Chicago, Ill.
§Eli Lilly & Company, Indianapolis, Ind.

STUDY CASTS

Accurate study casts should be made, duplicated, and articulated. One cast is retained as a duplicate of the mouth condition, while the other is corrected to demonstrate what will be done for the patient. The altered casts show which teeth remain in the mouth, the problem of restoring the remaining teeth, and the amount of interarch space. When all of the remaining teeth are to be replaced, the mouth can be shown as it is and with the dentures positioned in occlusion.

When the mouth is edentulous and surgical intervention is necessary, the articulated casts show the mouth as it is, the outline for surgical operation, and what can be done to make possible the construction of successful dentures. The altered casts can serve as a guide for the dental surgeon in the removal of superfluous tissue which would interfere with the success of new dentures.

ROENTGENOGRAMS

Complete intraoral roentgenograms are made of the partially edentulous mouth to determine which teeth can be retained. From the roentgenograms, periapically involved teeth, periodontal disturbances, imbedded teeth, the presence of foreign bodies, and the extent of caries can be determined. The roentgenograms reveal root deviation from the normal axial plane, root size of proposed partial denture abutments, the shape of the roots, and the extent of root support by the periodontal ligament and the lamina dura. The anatomic contour and general character of the bone are observed as well as cystic formations and atrophy.

Roentgenograms of edentulous dental arches reveal the location of stresses under old dentures, the thickness of the mucosa, the rapidity of resorption of the basal bone, and the character of the bone.

DIAGNOSTIC AIDS

I suggest the use of three books as an aid in diagnosis: (1) *Dynamics of Oral Diagnosis* by Cheraskin and Langley,[1] (2) *Dental Prosthetics* by Nagle and Sears,[2] and (3) *Oral Anatomy* by Sicher.[3] Books like these and others on prosthetics will help dentists make a more accurate diagnosis and construct dentures which will serve the patients better.

PATIENT EDUCATION

Patients must be prepared to know the possibilities and limitations of prosthetic restorations through education. The patient's knowledge of prosthetic dentistry is meager. He can be told, but he may not be in a receptive mood or he may forget the information before the dentures are constructed.

A printed letter pertinent to the making of the dentures and their limitations should be given to the patient prior to the construction of the dentures. Another letter about the care and use of dentures and their service, permanence, and the importance of the recall program should be given to the patient after the dentures are completed.

A book, *New Teeth for Old,*[4] should be read by every denture patient. It provides information in a manner that the patient can comprehend easily and creates a greater appreciation for denture service.

Two booklets have been prepared by the Complete Denture Section of the Detroit Dental Clinic Club. These booklets can be purchased and given to the patient. *A Few Tips From Your Dentist Concerning Your New Dentures*[5] serves as a guide in the use and care of complete dentures. It discusses speech, function, permanence, and service. There is also a discussion on immediate dentures. The second booklet is entitled *Nutrition for the Denture Patient.*[6] It is a guide in the proper preparation and use of foods and other nutritional products to enable the patient to receive the best possible service and comfort from his dentures.

CLINICAL FINDINGS

The clinical findings are evaluated as they are determined visually, digitally, and from the roentgenograms and study casts. The denture foundation tissue cannot be considered to be satisfactory if any infection is evident. Congested or hypertrophied tissue should be resolved or removed.

The gross anatomy of the upper and lower denture foundation is scrutinized to determine the location and height of the muscle attachments in relationship to the ridge. Pendulous tissue and underlying spines or rough bone are determined by palpation. These require either surgical removal or relief inside the denture base.

Extensive resorption of the residual alveolar ridge usually reduces the horizontal portion and increases the area of the lower ridge slope. The extent of the lower ridge that can be used for the positioning of denture teeth is limited to that part that can be made parallel with the upper ridge. Vertical closure may be necessary for adequate masticatory function when there is a great amount of resorption in the anterior part of the upper and lower edentulous arches.

The size and shape of the tongue are determined, as well as its position in the mouth. The patient should be informed that the positioning of the tongue around new dentures requires a period of adjustment because the tongue will change its dimensions. Thorough examination of the tongue for pathologic conditions such as carcinoma or leukoplakia is necessary. The patient should realize that the tongue is the taste organ and taste is not disturbed by the insertion of complete dentures. Many of the vitamin deficiencies show up as abnormalities in the tongue. Glossitis is a manifestation of niacin or riboflavin deficiency. Other vitamin B complex deficiencies produce glossitis or beefy red coloration, soreness, and eventually atrophy of the tongue.

The labial and buccal vestibule is studied to determine its irregularity and its size in relationship to the distance between the lips, the cheeks, and the remaining teeth. Denture teeth are often positioned so as to alter the form of the vestibule. No denture looks more artificial than one whose teeth and borders do not allow for a proper vestibular space.

Mandibular tori inhibit the function of dentures because the tori effect the valve seal and are painful upon the slightest pressure from the denture. Mandibular tori should be removed surgically, in most instances.

If the vertical dimension of occlusion is proper prior to the reconstruction of dentures, an outline form of the profile is made so that the same facial contour can be recorded in the dentures. If the vertical relation is closed too far, the profile is corrected by adding wax to the dentures. Then the vertical dimension to which the new dentures will be constructed is recorded. The profile record is of value in checking the vertical dimension from time to time to determine the need for changing the dentures.

Asymmetry, the height of the lip line, and any anomalies should be recorded. The patient's attention is called to these conditions prior to the denture construction.

The patient's old dentures are examined both in and out of the mouth to determine if the denture base is adequate in adaptation and coverage of the basal seat. The amount of vertical closure is determined by the vertical and horizontal overlap. The appearance and the occlusion of the dentures are observed.

GERIATRICS

Many patients are senile and lack the ability to adjust physically to dentures. Geriatrics and prosthetic dentistry cannot be separated, since more than 12,000,000 persons over 60 years of age wear dentures.

Charles F. Kettering said, "One cannot exact the application of mechanics to a base that is not constant." Therefore, an attempt must be made to maintain a balance between bone resorption and bone formation for older prosthetic patients. A parallelism between the anabolic rate and catabolic rate must be maintained if possible. Such a phenomenon is called metabolic homeostasis; it enables the ridge tissue to be maintained and not resorbed.

PATIENT NUTRITION

A well-balanced diet is necessary whether the patient is young or old or has natural teeth or complete dentures. Adequate food plays a large part in health. However, older denture patients do not have a selective diet that offers the variety of foods necessary for a balanced diet. They generally eat foods that are high in carbohydrates. Older denture patients should have diets which are rich in protein, natural vitamins, and minerals. These diets should be supplemented by large doses of synthetic vitamins. Older patients often suffer from fatty degeneration of the liver which results from the lack of choline. This is a lypotropic vitamin which is a hope against coronary heart attacks, cerebral hemorrhages, and kidney disease, all of which are related to the piling up of fat in the liver. Rutin is also important. It is used to improve capillary strength and to correct increased capillary fragility and permeability. Taka-Diastase* is a fine starch digestant. Geriplex* is a vitamin-mineral combination that contains these elements as well as other vitamin derivatives.

Myadec* is another high potency vitamin-mineral combination that is used to treat patients who have symptoms of poor nutrition and who require dietary restrictions for obesity, diabetes, peptic ulcers, or hepatitis. This preparation may

*Parke, Davis & Company.

be used also for chronic fatigue, loss of appetite, or irritability which occurs in an older patient attempting to adapt to new dentures. Myadec contains nine vitamins and eleven minerals.

Geriatric patients often have a diet from which body-building protein is almost absent. Whole milk, an excellent protein food, is widely avoided in corrective diets because of its high content of fat. Skimmed milk, although it is rich in protein and the fat has been removed, is often rejected because of its taste. However, nonfat dry milk solids are rich in proteins, vitamins, and calcium and are quite palatable. One such preparation is Meritine,* which can be purchased from any pharmacy. It is particularly helpful to senescent patients who are denture wearers. It is a powdered product that can be mixed with water or milk, and it mixes instantly. Four level teaspoonfuls added to one cup of milk makes a delicious Meritine milkshake. It is good as an eggnog or as a malted milk. Meritine tastes excellent when mixed with fruit juices.

FEE DETERMINATION

Fees for denture patients should vary with the time and skill required and the difficulties encountered in the treatment. Unfortunately, many dentists standardize their fees for all denture patients regardless of what service is necessary. The fee can only be determined after the diagnosis is complete.

Techniques and materials should not be discussed with patients in determining the fee. The fee should be determined on the basis of appearance, comfort, function, and service to the denture patient.

SUMMARY

The examination record should contain, in simple form, all the entries necessary to record complete information on the patient. The diagnosis becomes more complete at each subsequent appointment through increased knowledge of the patient's health, his emotional status, and the expectations he has regarding dentures.

Therefore, a good diagnosis is based on a complete history of the patient. Such a history includes his physical health as well as his emotional status. Also a profile record, the facial contours, vertical dimension, lip line, and asymmetry should be recorded.

A clinical diagnosis can only be made after a thorough visual, digital, and roentgenographic evaluation. Accurate, articulated study casts are of great value.

The dentist should make use of educational diagnostic aids to enable him to serve his patients better.

The patient should be prepared psychologically to receive dentures by making use of an educational program which consists of personal explanations and books and pamphlets.

The patient also needs to be prepared physiologically by establishment of a proper diet which includes nutritional elements supplemented by adequate dosages of vitamins and minerals.

*The Dietene Co., Minneapolis, Minn.

REFERENCES

1. Cheraskin, E., and Langley, L. L.: Dynamics of Oral Diagnosis, Chicago, 1956, Year Book Publishers, Inc.
2. Nagle, R. J., and Sears, V. H.: Dental Prosthetics; Complete Dentures, St. Louis, 1958, The C. V. Mosby Company.
3. Sicher, H.: Oral Anatomy, ed. 2, St. Louis, 1952, The C. V. Mosby Company.
4. Sears, V. H.: New Teeth for Old, ed. 3, St. Louis, 1959, The C. V. Mosby Company.
5. Detroit Dental Clinic Club, Complete Denture Section: A Few Tips From Your Dentist Concerning Your New Dentures, ed. 12, 1957.
6. Detroit Dental Clinic Club, Complete Denture Section: Nutrition for the Denture Patient, J. Pros. Den. **10**:53-60, 1960.

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PROCEDURES IN COMPLETE DENTURE PROSTHESIS

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CHANGES IN ANATOMIC STRUCTURES caused by aging and injury make it hardly probable that any single technique or restoration can make success in denture construction a routine matter. Denture techniques must be varied in accordance with the needs of the individual if results are to be consistently satisfactory.

This article stresses reasons for failure in complete denture construction and offers suggestions to promote a greater margin for success. The suggestions are not short cuts in technique, for the best efforts can be ruined by such desires.

BASIC TECHNIQUES

Dentists employ two basic techniques for the making of complete denture impressions. One technique, the pressure technique, utilizes pressure to some degree for the relief of hard tissues and the displacement of soft tissues. The other technique follows the thought that there must not be pressure on the tissues when the impression is being made.

Dentures made by the pressure technique give the best results when they exhibit horizontal stability, adhesion, and full-functioning borders.

Full-functioning denture borders are made from impressions with smooth, border-molded, rounded edges that end on movable tissues. The borders must not disturb the function of the musculature.

Horizontal stability is obtained when the greatest amount of denture foundation is included within the denture base.

Adhesion is obtained by contact of the denture base with soft tissue. This contact always produces an uncertain amount of displacement of the underlying tissues. The resulting displacement will not affect the efficiency of the denture adversely if there is a bare minimum of tissue contact. This bare minimum of tissue contact is called "contact compression."

ORAL EXAMINATION

Success in denture construction depends upon the recognition of the contacted anatomic structures. When the upper lip is raised, the labial frenum is exposed. The length, width, and direction of movement of this frenum must be studied carefully. The frenum should not be excised indiscriminately. A narrow labial frenum helps in the retention of a denture when the impression is properly and carefully border molded around it (Fig. 1). A fan-shaped, broad labial frenum,

however, must be handled with extreme caution. The functional movement of this frenum may lead to an underextended border. A completed denture made from an impression with an uncontrolled, fan-shaped frenum has a short, underfilled labial border (Fig. 2). The final result is a loose-fitting denture.

The distance between the posterior end of a torus palatinus and the vibrating line must be noted. The denture should extend at least 2 to 3 mm. beyond the distal end of the torus palatinus and anterior to the vibrating line. If the available area is less than the required amount, the movement of the vibrating line in function permits the ingress of saliva, water, and air under the denture into the area of relief for the torus and causes the denture to lose retention. This cause for failure can be eliminated by extending the denture onto the soft palate or by heavily beading the posterior palatal seal area.

The angle of movement of the soft palate is noted as the patient says "ah." When the soft palate drops away from the hard palate at a sharp downward angle (class II and class III throat form), the posterior palatal seal area should be beaded heavily.

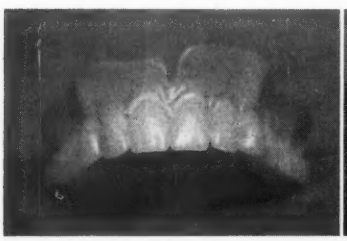

Fig. 1

Fig. 2

Fig. 1.—A narrow frenal notch usually aids in the retention of a complete denture.
Fig. 2.—A broad, fan-shaped frenum must be controlled or the denture border will be underextended.

It is important to gauge correctly the height of the buccal vestibule and the amount of space between the maxillary tuberosity and the structures lateral to the tuberosity. The proper contact of the polished surface of the denture against these tissues is necessary for the reseating of a denture that may be unseated in function.

The mandibular basal seat must be examined, and the related anatomic structures must be recognized. The mandibular frena must receive the same care and attention that were given to the maxillary frena.

If the mandibular ridge is knife edged with bony projections and if the patient does not permit surgical correction, the position of these projections must be noted. They can be relieved later by placing tinfoil on the cast.

The inclination of the external oblique line and the anterior border of the ramus are examined as they extend backward past the retromolar area. This border discloses the inclination of the buccal finishing line of the completed denture.

The floor of the mouth, the movement of the mylohyoid muscle, and the shape of the mylohyoid ridge must be studied. The position of the sublingual gland must be noted because this gland can withstand contact displacement by the denture.

The space between the ridge and the openings of the submaxillary gland (submaxillary caruncles) and the attachment of the geniohyoid muscle at the superior genian tubercles determines the width of the anterior lingual border of the lower denture. This area is most important for lower denture stability.

The proximity of the mylohyoid ridge and the mental foramen to the crest of the ridge must be recognized. In older patients, these two structures are near the superior surface of the mandible because of natural bone resorption. They must be relieved on the cast to prevent future sore spots and pressure areas.

IMPRESSIONS[1]

Making the Upper Impression.—A metal tray with flanges which extend to cover all of the area that must be recorded in the finished impression is selected. The handle of the tray is bent so it does not distort the lips (Fig. 3). A roll of softened modeling compound is placed in the tray so it extends about ¼ inch beyond the borders of the tray. The tray is seated in the mouth with a minimum of pressure. The patient is asked to move the lips forward as in kissing and then backward as in smiling, also to close the mouth and then open widely and say "ah." The last two movements should register the location of the vibrating line, which is to be the posterior limit of the denture. Then the impression is chilled and removed from the mouth.

The impression is removed from the tray and the highest limits of the borders are marked with a pencil. The modeling compound that could cause tissue distortion at the borders is cut away (Fig. 4), and the borders are molded. The border molding of the tray can be completed accurately because no excess material is present to distort the tissues. After the border molding is completed, a metal staple (to act as a handle) is attached to the anterior part of the tray at an angle so that it will not distort the lips.

The upper impression is completed with zinc oxide and eugenol impression paste in the border-molded tray. The tray is loaded with the impression material

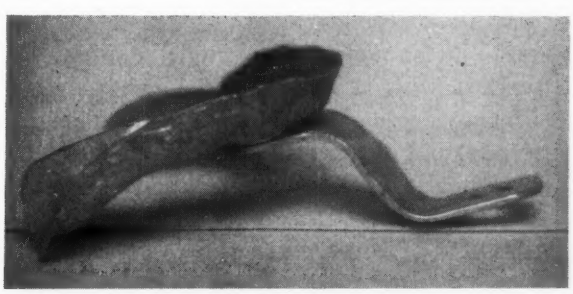

Fig. 3.—The handle is bent away to permit a more accurate registration of the lip and muscles.

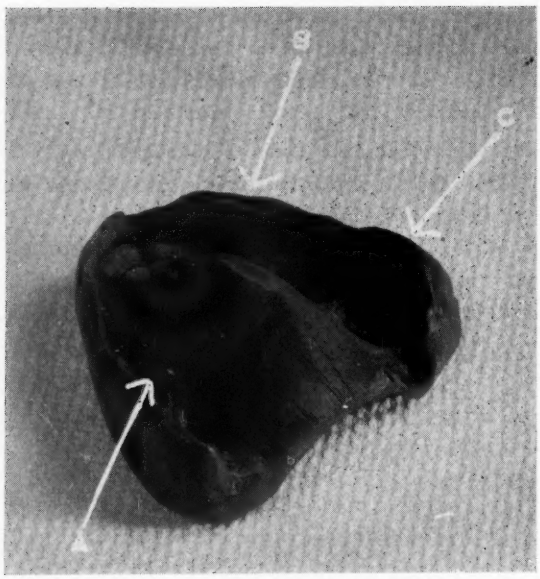

Fig. 4.—A modeling compound impression: *(A)* the side with the excess modeling compound removed; *(B)* the pencil outline of the highest limits; *(C)* the untrimmed side.

and placed into position in the mouth with a minimum of pressure. A bare minimum of contact with these tissues is all that is required. If too much pressure is exerted, an excess of impression paste is squeezed away from the hard tissues onto the soft tissues. This procedure causes unfavorable tissue displacement, and a poorly fitting, troublesome denture is the final result.

The impression is not removed from the mouth by the handle of the tray, but it is released by raising the upper lip and blowing air between the impression and the mucosa in the cuspid region. If this method does not release the impression, the patient gargles with water, spits out the water, and forcibly blows down the impression. Pressure on the handle of the tray would cause distortion of the impression borders in undercut areas (Fig. 5).

Making the Lower Impression.—A tray whose flanges extend to cover all the area that must be recorded in the finished impression is selected. The handle of the tray is bent so it does not distort the lips. A roll of softened compound is placed in the tray so that it extends about ¼ inch beyond the borders of the tray. The tray is seated in the mouth with a minimum of pressure. The patient is asked to move the lips forward as in kissing, then backwards as in smiling, to move the tongue from one corner of the mouth to the other corner, to touch the upper lip with the tongue, and to touch the palate with the tongue. Then the impression is chilled and removed from the mouth.

From this impression a stone cast is made. On this cast, the probable limit of the denture border is marked with a pencil. An acrylic resin tray is made with borders which are short of this pencilled outline. The tray should extend to cover one-third of the retromolar pad. A line dropped at right angles to the

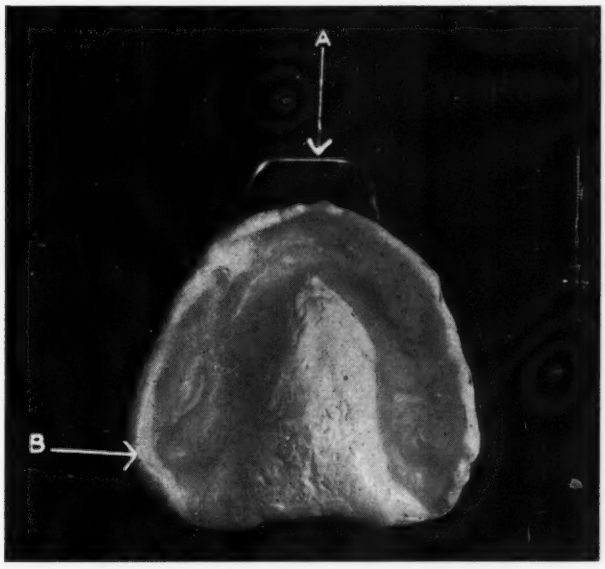

Fig. 5.—The final upper impression causes little tissue displacement.

surface of the pad at this point into the floor of the mouth below the level of the mylohyoid ridge determines the distolingual limit of the tray.

The buccal surface of the buccal flange of the resin tray is hollowed out in the molar and bicuspid regions to permit the cheek and buccinator muscle to fold over onto this concave surface during the making of the final impression. This contour serves as a retentive force for the completed lower denture.

The tongue must never be crowded. Therefore, the lingual surface of the lingual flange of the resin tray is hollowed out, and the anterior part of the lingual surface is kept flat. A handle is attached to the anterior part of the tray at an angle so that it will not distort the lips.

The resin tray is border molded in the mouth with modeling compound. Then the lower impression is completed with zinc oxide and eugenol impression paste in the border-molded tray. The impression paste is placed only on the borders of the tray. When the tray is placed in position in the mouth with a bare minimum of pressure, the paste will flow slowly to the crest of the ridge without producing undue and unfavorable tissue displacement. Many lower dentures fail because of too much tissue displacement on the crest of the ridge when the impression is made (Fig. 6).

JAW RELATION RECORDS

There is a great need for a simple and positive technique for making centric relation records. An incorrect centric relation record is one of the most common causes for failure of complete dentures. The patient must be relaxed and cooperative to use the mechanical recording appliances successfully. These devices have

not eliminated the failures. Does the fault rest with the patients because they do not give the necessary and required assistance, with the inaccuracy of the recording devices, or with a lack of skill on the part of the dentist?

Every vertical dimension of occlusion has its own centric relation. The vertical dimension of occlusion is the amount of interridge space left after the interocclusal distance is deducted from the physiologic rest dimension. However,

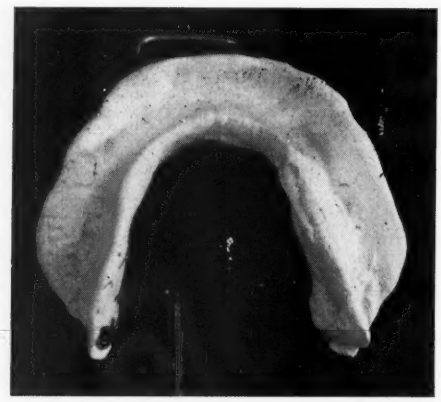

Fig. 6.—The final lower impression is made in a cold-curing acrylic resin tray.

Coulouriotes[2] said, "It seems quite evident from the material that has been presented that not one scientific and absolute method whereby an exact free-way space can be determined and measured is available at present." Techniques for determining the rest position do not assure the accuracy of these records. Nevertheless, sufficient interocclusal distance must be provided. Since the vertical dimension of occlusion is not necessarily accurate, the centric relation record is not necessarily accurate either.

The physiologic rest position is determined by means of caliper measurements from the most forward point on the chin to a point near the prominence of the nose. This distance is measured after the patient takes a deep breath, says *m* in a humming fashion, and slowly brings the lips together into light contact so that he feels the lips vibrating when the letter is being produced. While the lips are in light contact and the letter *m* is being produced, the caliper measurement is made. It is always safer to use a larger interocclusal distance for aged patients because of the greater amount of bone resorption and tissue loss.

The upper lip is examined before establishing the height of the upper occlusion rim. If the lip is short and has an upward curl, more of the anterior teeth will show than if the lip is long. The upper occlusion rim is adjusted for lip contour. The occlusal surface must parallel the interpupillary line and a line from the tragus of the ear to the ala of the nose.

The lower occlusion rim is softened until its contact with the upper occlusion rim produces a caliper reading that is approximately 3 to 4 mm. less than the

caliper reading obtained when the physiologic rest position was determined. This new caliper reading is the vertical dimension of occlusion.

The centric relation record is produced with an intraoral tracer whose set screw (central bearing point) is attached to the upper occlusion rim and whose tracing table is attached to the lower occlusion rim. Because all the determinants—the physiologic rest position, the interocclusal distance, and the vertical dimension of occlusion—may be incorrect, this method for producing the centric relation record must be considered an empirical method.

TOOTH ARRANGEMENT

Dentures made from a good impression and centric relation record will fail if the tongue is crowded. Ample space for any and all tongue movements *must* be provided. A mental picture of the length and width of the tongue must be retained. The use of a tooth that is narrow buccolingually produces more space for the tongue. If necessary, the lingual surfaces of the posterior teeth are ground to produce more tongue space.

The lingual surfaces of the upper and lower bicuspid and molar teeth and the vertical alignment of the lower anterior teeth cause crowding of the tongue more often than any other tooth factors. Since denture teeth are not anchored

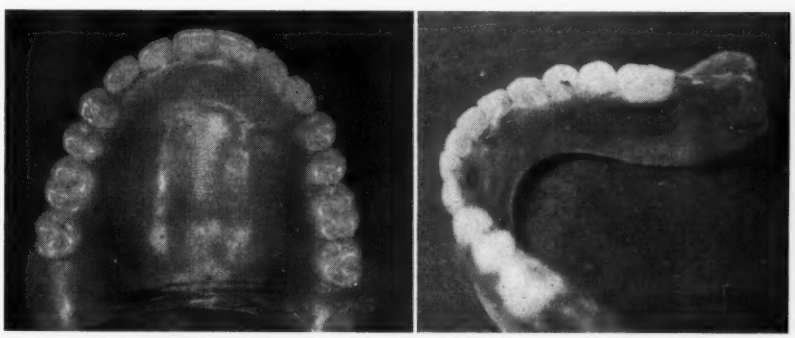

Fig. 7 Fig. 8

Fig. 7.—The curve of the dental arch is widened in the upper bicuspid and molar region.
Fig. 8.—The lower anterior teeth are inclined labially for more tongue space.

in bone as are the natural teeth, the tongue, with all its strengh and movements, can unseat and displace the most accurately constructed denture. Therefore, the arch form of the bicuspids and molars is widened from the distal surface of the cuspid to the mesial surface of the last molar. The distal surface of the last molar is turned inward slightly (Fig. 7). The lower anterior teeth are inclined slightly labially to give the tongue more space to move forward (Fig. 8).

The posterior teeth of the upper denture should be arranged 1 to 2 mm. labial or lingual to the buccal surface of the lower teeth. The scissorlike setup of the buccal surfaces of the upper molars and bicuspids directly over the buccal surfaces of the lower bicuspids and molars causes cheek biting.

Advancing age causes changes in the size relationship between the edentulous maxillae and mandible because of the direction of resorption of the residual alveolar bone. The change is such that the residual arch of the mandible becomes larger while the residual arch of the maxillae becomes smaller. Therefore, in many instances, the posterior teeth must be set up in a "cross-bite" position.

When a definite incisal guidance is used, a space of about 1 to 2 mm. should be present between the upper and lower anterior teeth in centric occlusion. This space permits protrusive movement of the mandible without unseating the upper denture. In general, the horizontal and vertical overlap of the upper anterior teeth must be kept to a minimum, especially when nonanatomic (cuspless) teeth are used. If a nonanatomic tooth is used, a shallow incisal guidance and a shallower condylar guidance should be developed in the setup of the teeth.

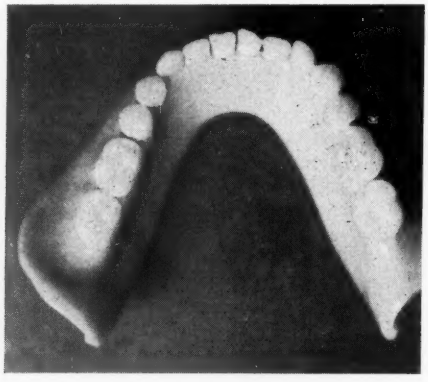

Fig. 9.—The concave surface of the buccal flange permits the cheek and buccinator muscles to aid in the retention of the denture.

THE PROCESSED DENTURE

The processed denture must reproduce faithfully the smooth, rounded borders and notches for the frenula that were present in the final impression. This can be accomplished with a boxed impression and carefully formed casts. All polishing of the borders must be done with care. The lingual flanges are waxed in a saucerlike fashion, and a minimum of wax is placed on the lingual surface of the anterior flange. Thus, the tongue is permitted easy side-to-side movement and forward thrust during mastication, speech, and deglutition. The polished surface of the lower denture in the buccal molar and bicuspid regions is waxed in a saucerlike shape (concave) to permit the cheek and the buccinator muscles to rest on this surface for greater retention (Fig. 9).

DENTURE INSERTION

The insertion of a denture should follow a definite pattern and technique. The patient should be prepared psychologically to accept the denture.

The dentures are inserted into the mouth. The patient is told to open and close the mouth ten times and then to stop with the teeth in contact. At this time, the patients lips are parted and the accuracy of the centric occlusion can be noted. The patient holds this position for about 5 minutes to allow the tissues to become adapted to the denture bases.

The dentures are removed from the mouth and adjusted individually to the contacted anatomic findings by use of a disclosing paste. A small amount of the disclosing paste is placed on the denture border in the tuberosity region. The denture is placed in position, and muscle movement and tissue contact squeeze the paste away from the denture surfaces which are in too close contact with the mucosa and could cause abrasion and pain. The denture is removed from the mouth, and any exposed denture-base material within the disclosing paste is

Fig. 10

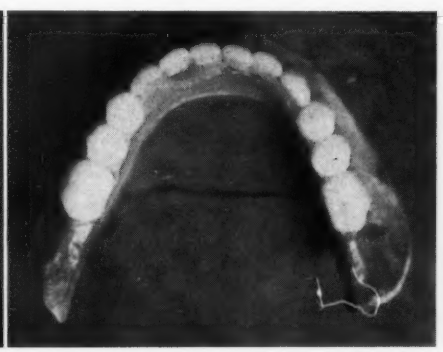

Fig. 11

Fig. 10.—The concave lingual flanges and the flat anterior lingual surface allow more space for the tongue.

Fig. 11.—The widening of the molar and bicuspid arch curve allows the tongue freedom to move.

ground to a small depth. The denture is again covered with paste, placed in the mouth, and checked until there are no bare areas of denture-base material showing through the disclosing paste. This treatment is continued from tuberosity to tuberosity to relieve all possible vertical stress line pain areas. The posterior palatal seal area, which is a horizontal stress line and is most important for the stability and retention of an upper denture, is not changed.

If frenal movement is impeded, the direction of movement of the frenula is studied in the mouth. The notches for the frenula in the denture are ground with a cup-shaped (outside grit) carborundum disk in the direction of the observed movement.

The disclosing paste is also used on the borders of the lower denture. All possible overextensions along the outer border of the mandible, the external oblique line, the floor of the mouth, and the region of the genian tubercules are determined. There must be ample tongue space at all times. Therefore, the lingual flanges are examined for the required concave shape, and the denture material on the anterior lingual flange is examined for flatness (Fig. 10).

The bicuspid and molar teeth are examined to see that they do not extend too far lingually (Fig. 11). The anterior teeth are examined to see that they have a slight forward labial inclination. The teeth are spot ground to remove the obvious deflective occlusal contacts.

The patient is instructed not to use the dentures for eating purposes for 2 days and 2 nights. If the dentures cause soreness during talking and swallowing, surely the force of mastication will increase the discomfort. The patient is instructed that only if he is in great pain should he remove the dentures from the mouth.

When the patient returns, any areas of soreness can be located with the disclosing paste. The teeth are again spot ground to remove all obvious deflective occlusal contacts. The patient is told to return in 3 days.

REGRINDING THE OCCLUSION

One week later, when the dentures do not exhibit any soreness, the teeth are ground into occlusion for function. If the residual alveolar foundation of the maxillae is of good size, if the palate has a high vault, if the ridges have good length, or if the soft palate slopes away from the hard palate at a slight angle (class I throat form), the most stable lower denture will be produced by grinding the teeth into the reverse curve. This curve is produced by grinding the lingual cusps of the upper bicuspids and molars and the buccal cusps of the lower bicuspids and molars. However, if the maxillary residual alveolar foundation is small, if the palate is flat, if the ridges are short, or if the throat form is class II or III, it is best to grind the teeth into the compensating curve. This curve is produced by grinding the buccal cusps of the upper bicuspids and molars and the lingual cusps of the lower bicuspids and molars. When the maxillary foundation is poor, the teeth must be ground into the Monson curve. An intraoral balancer is used to assist in grinding the teeth into occlusion. The first observation is that,

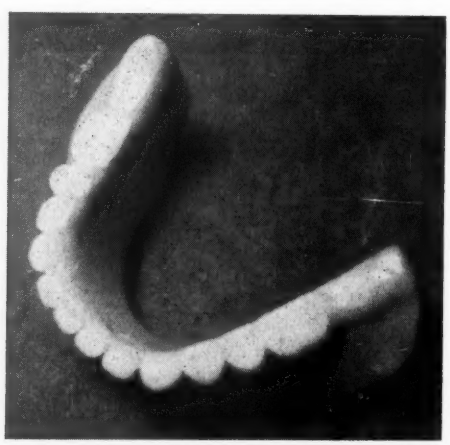

Fig. 12.—Posterior ramps are added to provide balancing contacts in eccentric positions.

while the pin of the balancer keeps the teeth out of occlusion when the dentures are held together in the hand, articulating paper will disclose that there are deflective occlusal contacts between the teeth in the mouth. The mouth is the best articulator for the adjustment of the teeth.

Nonanatomic teeth, when set up with a shallow incisal guidance and a shallow condylar guidance and when ground into the reverse curve, added to the stability of the dentures. The use of the nonanatomic tooth permits longer and easier gliding contacts of the teeth. This technique helps to prevent the breakdown of the residual alveolar bone and is necessary for those patients who are victims of bruxism.

A balancing ramp is added after all the teeth have been ground into occlusion with the intraoral balancer. Petroleum jelly is applied to the denture-base material and teeth of the upper denture in the molar and tuberosity areas. It is applied also to the last molar and the denture-base material of the lower denture. A thick mix of cold-curing acrylic resin is placed distal to the last tooth of the lower denture. The patient is guided to make occlusal contact. After a few minutes, the dentures are removed and the resin completes its curing outside the mouth. The ramp is adjusted with articulating paper in the mouth to prevent interference during lateral or protrusive movements (Fig. 12).

GAGGING

Not all gag reflexes are caused by psychologic disturbances, menopause, or poor anatomic conditions in the posterior part of the mouth. The tendency to gag, in many instances, can be diminished by reducing the vertical dimension of occlusion. This change permits an easier closure on the back teeth so that the patient can swallow saliva more easily. Too great a vertical dimension and the difficulty in swallowing cause saliva to collect in the back of the throat and initiate the tendency to gag. The tendency to gag can also be diminished by reducing the amount of denture-base material on the palatal surface of the denture, especially the denture-base material that is palatal to the last molar tooth and the tuberosity. Anything that impedes the forward thrust of the tongue prevents the proper closure of the jaws and interferes with deglutition.

SUMMARY

Many successful complete dentures are produced by the use of many different techniques. Every dentist should use that technique which is best suited to his skills. Suggestions have been made which can complement and supplement other techniques for producing complete dentures.

REFERENCES

1. Sussman, B. A.: Upper and Lower Impression Technique as Developed in the Mt. Sinai Hospital Dental Department, J.A.D.A. **31**:1346, 1944.
2. Coulouriotes, A.: Free-way Space, J. Pros. Den. **5**:194, 1955.

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TROUBLE SHOOTING IN COMPLETE DENTURE PROSTHESIS
Part VII. Mucosal Irritations*

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CHARACTERISTIC SORENESS FREQUENTLY APPEARS on the upper and lower labial frenula. The primary irritation is on the frenum itself, and the irritation spreads laterally on both sides.

The upper labial frenum for most patients requires more space for movement than is provided in many instances. Even when the upper frenum does not become ulcerated, it is frequently imprisoned, and the upper lip becomes restricted in its physiologic movements. Therefore, when soreness does appear in the region of the frenum, the denture should be relieved more generously than elsewhere.

The upper lip, in a drooping position, effects a border seal even when the denture is slightly underextended in the frenal region. If the frenum alone is irritated, relief is limited to the deepest portion of the labial notch. The upper borders on both sides of the notch are rounded to provide more space for movement of the frenum. This applies to the long, thin, stringlike, resistant frenum which fits into a deep, narrow labial notch.

The short, wide, flabby, nonresistant frenum frequently attaches almost to the crest of the residual alveolar ridge. Some dentists believe that the low frenal attachment is the "Achilles heel" through which air penetrates into the tissue surface of the denture. In deciding to remake such dentures, they first raise the frenum by surgical procedure. Frequent disappointments follow such procedures because the responsibility for the failure is misplaced. The loose adipose tissue surrounding such a frenum usually forms a good denture seal with a drooping upper lip. Irritation of a frenum of this type, when it does occur, is usually wider in area and should be relieved accordingly.

Irritation to the mucosa in this area may emanate from two sources: (1) an overextended denture border over which the movable soft tissue rubs and (2) a knife-edge denture border.

TUBEROSITY SORENESS

Mucosal soreness is seen frequently on the buccal surface of the right and left maxillary tuberosities. When the tuberosities are undercut, the finished, rigid denture will not seat into position except when forced past the most prom-

*Part I, J. PROS. DEN. 9:978-987, 1959; Part II, J. PROS. DEN. 10:42-46, 1960; Part III, J. PROS. DEN. 10:263-269, 1960; Part IV, J. PROS. DEN. 10:490-495, 1960; Part V, J. PROS. DEN. 10:682-687, 1960; Part VI, J. PROS. DEN. 10:887-890, 1960.

inent buccal projections. The forceful friction of the tissue surface of the denture against the buccal prominences of the maxillary tuberosities during insertion and removal of the dentures causes severe ulcerations and a great deal of pain. The pain may become so severe as to make it impossible for the patient to reinsert the denture before the ulcerations have healed completely.

This type of soreness can be obviated by proper handling of the dentures at the time of insertion. The roof of the vestibulum oris over the maxillary tuberosities is usually wide and square and forms the postmalar pocket. The denture border should fill this pocket to obtain an adequate border seal. If this is done, the tissue surfaces of the tuberosity flanges can be reduced to enable the denture to slip over the widest buccal prominences of the upper tuberosities, and the border seal will be maintained.

Careful examination of these tuberosity ulcerations reveals that they are usually round but may be either small or large. Their size depends upon the size and shape of the buccal prominences of the tuberosities. If the prominences are pointed, the ulcerations will be round and small. If the prominences are shallow and broad, the ulcerations will be round but of much larger size. During the first 24 to 48 hours, only redness may be observed on the irritated tissues. After this period, the tissues become ulcerated, sloughing white, circumscribed, and extremely painful to contact with the denture or even with the finger. The entire mucosa may slough off, exposing the bone.

SURGICAL REMOVAL OF BONE

Bony undercuts are removed only when necessary, because the alveolar bone is the foundation for dentures and it is too precious to be sacrificed whenever there is any chance to spare it. There are many ways to save the alveolar bone and yet maintain the fit of the dentures. This does not apply, however, to prominent, sharp bony projections, since they only interfere with proper seating and functioning of the dentures. These projections should be removed surgically prior to construction of the dentures, or they may be removed surgically during the phase of adjustment of the dentures. Only the projecting *sharpest points,* not the substance of the alveolar bone, are removed. Extensive alveolectomy prior to construction of dentures should not be undertaken. The patients seldom, if ever, benefit from such procedures.

DEVELOPMENTAL STAGES OF CERTAIN ULCERATIONS OF THE MASTICATORY MUCOSA

Under certain circumstances and in special parts of the masticatory mucosa, three stages are observed in the development of an ulceration. This occurs most often on the lingual side of the lower alveolar ridge, particularly on its anterior segment. The three stages are: (1) superficial redness of the mucosa of the involved tissue appears, (2) the tissue becomes grayish in color, slightly granular in appearance, and slightly coarse or rough to the touch, and (3) the tissue becomes whitish in color, slough, and irregular in outline.

The trauma that is most likely to cause this type of ulceration is unremitting pressure. The condition is most easily corrected in its second stage, provided the finger is not passed over the sore spot too many times. Should this be done, the area is liable to be "lost," because passing the finger over it several times, particularly with pressure, may result in the disappearance of the coarse feeling as well as in a fading away of the grayish appearance. To relieve a sore spot on the mucosa, it must be correlated exactly with the corresponding spot on the denture that constitutes the source of the trouble.

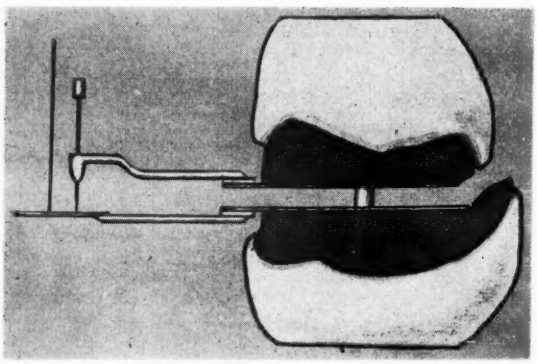

Fig. 1.—The central bearing point is conducive to recording the centric jaw relation without strain. The parallelism between the stylus and the adjacent vertical rod indicates that the occlusal rims are in vertical equilibrium.

ATROPHIED LOWER RIDGES

The basal seat as a foundation for lower dentures has three different forms: (1) a convex basal seat, (2) a flat basal seat, and (3) a concave or negative basal seat.

A convex basal seat is one in which the predominantly cancellous alveolar bone is of average thickness and is considered an average, normal lower ridge (Fig. 1). A denture properly constructed upon such a foundation should not require an excessive number of adjustments if all the other features involved are favorable.

A flat basal seat is one in which the predominantly cancellous alveolar process has resorbed to such an extent that it has reached the level of the external and internal oblique lines. This form provides a broad seating surface for the lower denture but one of poor retentive qualities. Requests for a greater number of adjustments should be anticipated than with the convex form.

A concave or negative basal seat is one in which the predominantly cancellous alveolar process has resorbed to such an advanced degree that it has reached a level much below the external and internal oblique lines. The entire cancellous bone of the alveolar process has resorbed until the compact bone of the mandible has become the basal seat for the lower denture. The residual ridge has the form of a ditch or trench, bounded medially by the internal oblique line and

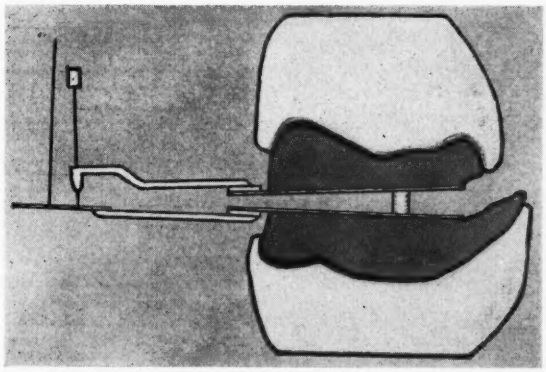

Fig. 2.—The bearing point is placed too far posteriorly. The completed denture will lack vertical equilibrium. If a similar method is used for adjustment of the occlusion on the completed denture, the point must be centralized properly.

laterally by the external oblique line. The internal and external oblique lines offer greater resistance to resorption because, as areas of muscle attachment, they are more highly calcified.

A properly outlined denture base for a concave basal seat should cover and overlap the mylohyoid ridge so that the tissues covering the free border of the lingual flange are in contact with the mylohyoid muscle. The buccal flange should cover the upper or occlusal part of the external oblique line and the base of the denture should completely fill the concave part of the residual ridge.

With a denture basal seat such as this, complications during the adjustment period may be anticipated. The mylohyoid ridge may be sharp, and the friction of the denture against this ridge may cause severe ulcerations. Such soreness is prevented with tinfoil on the cast or relieved with a round bur on the corresponding part of the denture.

Usually, soreness of a different nature is observed on the tissue covering the external oblique line. On the upper surface in the region of the second molar, the sore areas usually are round, grayish white, with a circumscribed area of hyperemia. From the first molar forward, the irritations are longitudinal and are accompanied by severe hyperemia.

To determine which part of the denture has caused the irritation on the external oblique line, the denture and the tissues are dried and indelible pencil markings are transferred from the denture to the tissues. The markings on the denture should be as small as can be made, and the jaw opening should be as small as possible when the denture is seated into position. With a wide jaw separation, the buccinator muscle becomes tense, the adjacent tissues are distended, and the pencil markings are smudged over a wide area.

The mucosa covering the external and internal oblique lines is usually loose, and the denture movement creates friction of the mucosa against the underlying bone. The mucosa then becomes edematous and slightly hyperemic but with no definite ulcerations. Thus, it is difficult to afford relief for the patient.

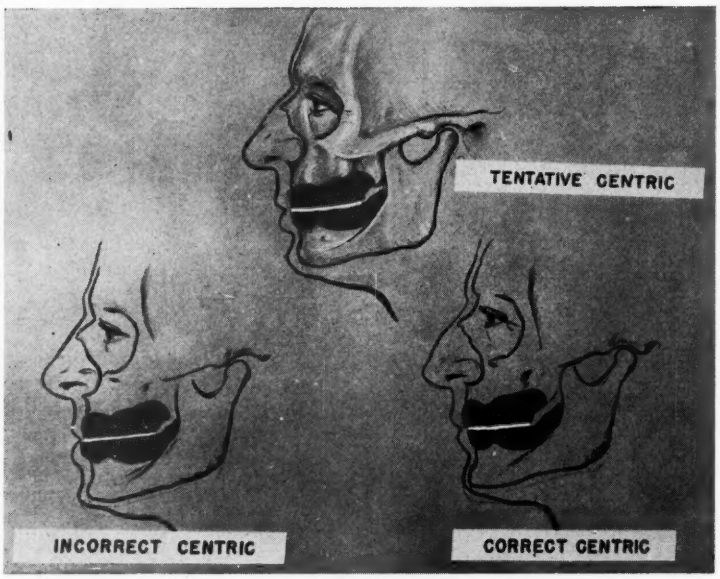

Fig. 3.—The centric jaw relation is recorded by means of soft wax interposed between the upper and lower occlusal rims. The same fundamental principles govern the recording of the centric relation for the original construction of the dentures as for checking and rechecking the jaw relations and occlusions after the dentures are completed. The records must be obtained *without strain* and with as close to zero pressure as possible.

Occlusion is of particular concern in the movement of such dentures. The occlusion must be checked and double checked, particularly from the mouth back to the articulator. The centric occlusion and centric jaw relation must be in perfect harmony (Figs. 1, 2, and 3). The buccolingual diameter of the posterior teeth should be as narrow as possible with no interlocking cusps. The occlusal surfaces should be highly polished and the tissue surface of the dentures

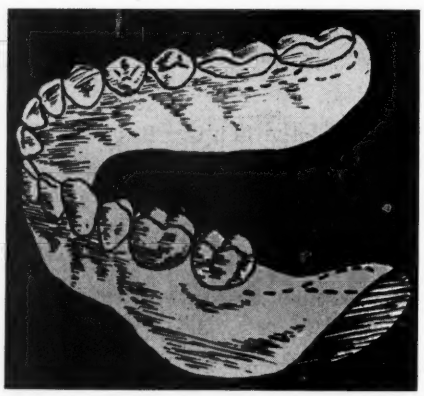

Fig. 4.—The teeth are set too far back on the retromolar pad on the right side, and on the left side, too far to the front. The distal surface of the second molar should always terminate slightly in front of the beginning of the retromolar pad.

should not be rough. The buccal and labial borders should be round and thick and properly extended to prevent the denture from gliding upon its supporting structures. The vertical dimension of occlusion should never be excessive and cause the alveolar ridges to depart from parallelism. Parallelism between the maxillary and mandibular ridges with the proper plane or curvature of occlusion midway between the ridges is extremely helpful in directing the occlusal forces perpendicular to the denture-supporting structures. Such perpendicular forces aid in denture stability and reduce the friction of the loose mucosa against its underlying bone. A slight maxillomandibular overclosure is preferred to a slight overopening.

The compensating curve should be eliminated completely or made so shallow as to render its adverse influence negligible. The best way to prevent dentures from skidding upon their supporting structures is to use teeth without cusps.

However, introducing a pronounced compensating curve defeats this purpose.

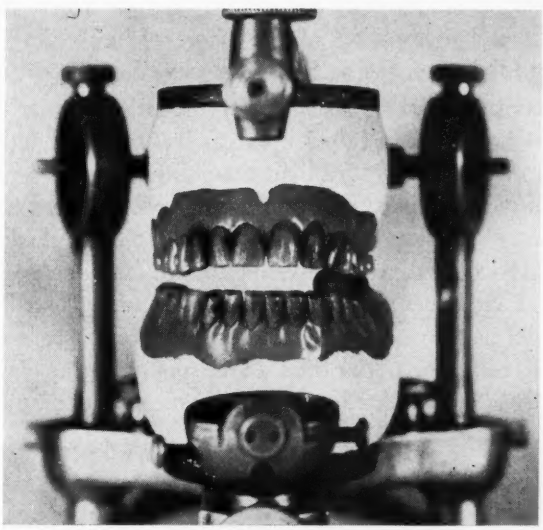

Fig. 5.—The artificial teeth must be placed as closely as possible over the crest of the residual ridge if stability of the dentures is to be maintained. This is called unilateral balance because it transmits the forces to the crest of the ridge, thereby eliminating leverage upon the denture.

CENTRALIZATION OF OCCLUSION FOR NEGATIVE RIDGES

Centralization of occlusion is the most important factor in denture stability, and it must be effected anteroposteriorly, laterally, and vertically.

Anteroposterior Centralization of Occlusion.—The posterior teeth are arranged in such a manner that the brunt of occlusion falls upon the second bicuspid and first molar. The posterior teeth should not only be narrow buccolingually but also short anteroposteriorly. The second molar should be in front of the retromolar pad (Fig. 4). Should even a part of the tooth be placed over the pad, denture stability is disturbed, particularly during the process of mastication. Should

a morsel of food be placed between the second molars and the pressure transmitted to the pear-shaped area, forward gliding of the lower denture follows with pain and bone resorption.

Lateral Centralization of Occlusion.—The teeth are set buccolingually and labiolingually in the same position as the natural teeth for a harmonious relationship between the dentures, the tongue, and the cheeks. It may be argued that the more the teeth are set in a lingual direction, the greater is the stability. On the other hand, many lower dentures are unseated by tongues cramped for space because the teeth were set too far lingually. The cheeks and lips also must maintain a harmonious relationship with the dentures.

Vertical Centralization of the Occlusion.—The occlusal surfaces of the artificial teeth are set as close to the crest of the ridge as other factors permit. The ideal condition is for the plane of occlusion to bisect the distance between the upper and lower ridges, but it is permissible to set the plane of occlusion a little lower to enhance stability of the lower denture when the lower ridge is poor. However, excessive lowering of the plane of occlusion may handicap the tongue in directing food upon the occlusal surfaces of teeth or cause tongue biting.

Occlusion is the mainstay in denture prosthesis for negative lower ridges (Fig. 5). The prosthodontist is called upon to build on the old ruins a new and efficient masticatory apparatus. More than that, the patient has gone through many pathologic patterns of occlusion to which he has had to adapt himself. It now becomes necessary to recondition the patient and select an occlusion suitable for the new and considerably altered environmental conditions. The new dentures will be called upon to function under artificial conditions and in a artificial environment. The patient must develop a new set of afferent and efferent reflexes suitable for the new environmental conditions. For this to be possible, the dentist must have a thorough knowledge of mechanics, biomechanics, anatomy, physiology, and psychology.

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CENTRIC AND ECCENTRIC OCCLUSIONS

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OCCLUSION IS ANY CONTACT of the lower with the upper occlusal surface. Occlusion may be balanced or unbalanced. Balanced occlusion in centric position exists with simultaneous contact of the right and left occlusal surfaces when the teeth are in centric occlusion. Balanced occlusion in lateral position is present with simultaneous contact of right and left opposing occlusal surfaces when the lower teeth are moved sideways. Balanced occlusion in protrusive position exists with simultaneous contact of the front and back opposing surfaces when the teeth are moved sagittally. These criteria of balanced occlusion apply to both natural and artificial teeth. For artificial teeth, they apply to both anatomic and nonanatomic forms.

APPLICATION ACCORDING TO THE SITUATION

The principles of tooth occlusions are the same in all branches of dentistry, but their application differs according to the situation. Perhaps the greatest difference of application exists between orthodontics and complete denture prosthodontics.

Essential differences between the two situations have been pointed out,[1] but they are given again as a basis for discussion:

1. Individual natural teeth are held by fibrous attachments in sockets of bone, whereas prosthetic restorations rest on slippery surfaces.

2. Individual natural teeth move slowly, whereas prosthetic restorations can be dislodged instantaneously.

3. Individual tooth movement is possible with natural teeth, whereas the entire prosthetic restoration moves as a unit.

4. Malocclusions of natural teeth, especially in young patients, may exist for years without apparent injury. The same malocclusions in complete dentures usually manifest themselves in a few hours.

5. Malocclusion of a natural tooth is detrimental to its immediate investing tissues. Malocclusion of a tooth on a complete denture is detrimental to the supporting tissues at other sites than the one underlying the malocclusion.

6. Horizontal pressure from the lingual side of a natural upper crown has no effect on the teeth on the opposite side, whereas such pressure on a prosthetic restoration tends to push the teeth on the opposite side horizontally.

7. Vertical pressure on the lingual cusp of a natural tooth has no effect on the teeth of the opposite side, whereas such pressure applied on the lingual side of the ridge crest on dentures tends to press the opposite side more firmly toward the

Read before the San Diego County Dental Society, San Diego, Calif.

tissues. Vertical pressure applied on the buccal side of one ridge crest tends to teeter the dentures, lifting them from the supporting tissues of the opposite side.

8. Interceptive contact of incisors in protrusion has no immediate effect on the natural posterior teeth, whereas such contact of prosthetic restorations tends to lift the posterior teeth of both dentures from their supporting ridges.

9. Interceptive contact of second and third molars has no immediate dislodging effect on the other natural teeth. However, such contact of prosthetic restorations tends to slide the lower denture anteriorly and to lift the anterior teeth from their supporting ridges.

10. Natural teeth in centric occlusion meet their antagonists throughout the entire extent of the dental arch, whereas in complete dentures only those teeth nearest the center of the denture foundation should meet their antagonists.

The problems of balanced occlusion should be treated from different standpoints because of these differences. An early appreciation of the mechanical requirements for different oral situations better equips the dentist to meet the problems of tooth form and tooth placement.

ANATOMIC OCCLUSION

The logical place to teach anatomic occlusion is in the department of orthodontics or, better still, in an autonomous department of dental occlusion. This is the logical place where the instructors are capable of teaching all phases of occlusion with natural teeth. Such instruction would require the use of a highly adjustable mechanism for controlling the movements of the lower cast of the teeth.

Before deciding the new positions of the individual teeth, the orthodontist should mount the casts on a suitable dental articulator and adjust the mechanism to the recorded or anticipated[2] centric and eccentric jaw relations of the patient. Testing occlusions with dentures or casts of natural teeth merely held by hand is unscientific. Indeed, the anatomic occlusal forms of natural teeth with which the orthodontist deals require more versatile and more exacting articulator adjustments than do artificial teeth designed especially for the edentulous situation.

The orthodontist is bound by certain anatomic features which have little pertinence in denture work. He should align the teeth for pleasing appearance, chewing efficiency, and preservation of the periodontal structures with due regard for the integrity of the temporomandibular joint and associated structures.

PROSTHETIC OCCLUSION

Until the dental schools in the United States establish autonomous departments of dental occlusion as has been done elsewhere, the departments of prosthodontics must teach the essentials of both natural and nonanatomic tooth forms and tooth positions.

Some of the essentials of tooth occlusion in the making of complete dentures are (1) smooth-gliding opposing surfaces, (2) absence of interference in horizontal movement, (3) lever balance, (4) balanced occlusion in centric position, and (5) balanced occlusion in the eccentric positions. Tests in many hundreds of mouths leave little doubt that all five of these are important. However, only the requirements of balanced occlusion in centric and eccentric positions will be discussed.

MERITS OF PROSTHETIC BALANCED OCCLUSION

It is sometimes claimed that there is no need for eccentrically balanced occlusions for complete dentures. Some theoretic considerations are involved, but the best way to resolve this question is to make tests in the mouths of patients. The tests should be for comfort, stability, and efficiency of the dentures, and subsequently for the condition of the tissues underlying the dentures.

With respect to bilateral balanced occlusion, it has been argued that because the teeth of the balancing side are held apart by food on the working side, the balancing surfaces have no effect. A phrase has been coined to bolster the argument—"enter bolus, exit balance."

Whatever validity there may be to the argument of "enter bolus, exit balance," carefully conducted tests show that dentures can be made more satisfactory by balancing the occlusion in all functional jaw relations. On inserting dentures with newly balanced occlusions, it is not uncommon for a patient to remark, "You tightened them, didn't you?" This reaction should not be surprising, because if every closure brings the right and left sides together simultaneously, the dentures are pressed evenly against their basal seats.

In many hundreds of tests, most patients reported increased comfort and stability of dentures with balanced occlusions. A few patients noticed no difference, but none found the change detrimental. Part of the explanation for the lack of unanimity is that other variables were present, such as smooth gliding of opposing surfaces, absence of cuspal interference, and lever balance.

BALANCED OCCLUSION IN GENERAL

Centric occlusion is the contact position of the lower teeth against the upper teeth at which all horizontal centripetal movements end. Any horizontal deviation from this position results in eccentric occlusion. Centric occlusion of the teeth should coincide with centric jaw relation. Although the two positions can be made to coincide exactly with each closure on a sturdy articulator, this is not true in the patient's mouth.

The mandible is not a part of a precision machine and does not always close at exactly the same place.[4] Leaning the head will cause the mandible to close somewhat in the direction of the lean.[5] Even without this tilt there is often a slight shift away from the "center" position. Posselt writes of his tests, ". . . In no case were the functional positions situated on the hinge movement paths."[6]

A degree of freedom should be provided in the occlusion at centric jaw relation. The opposing teeth should meet in a restricted area rather than at a point. This provision is especially important if cusp inclines are present to cause horizontal shifting of the dentures when the teeth are closed away from the exact centric occlusion.

NONCHEWING OCCLUSION

This horizontal freedom of movement near centric occlusion is especially important when no food is present. There are two phases of balanced occlusion. The first and perhaps the more important phase pertains to tooth occlusion *without* interposed food. The second phase pertains to tooth occlusion *with* interposed food.

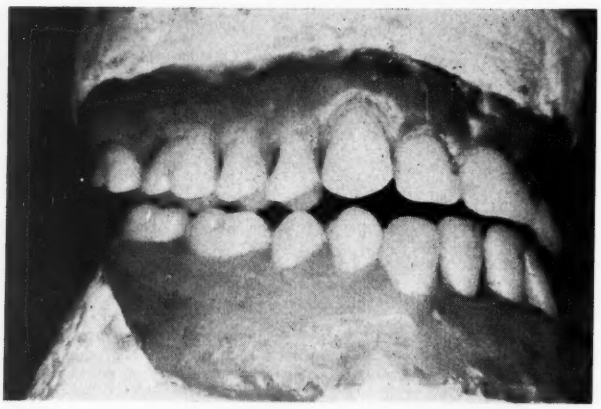

Fig. 1.—The anatomic scheme of occlusion maintains all of the upper lingual cusps in contact with the lower buccal cusps on the balancing side.

One reason that balanced occlusion is important in the absence of food is that the teeth are brought together so frequently between meals. Since closures are not always at the same horizontal position, it is necessary to give attention to the occlusions that occur "at and near" centric jaw relation. The beneficial effect of balanced occlusions "at and near" centric jaw relation in the absence of food may explain why some dentists who use flat plane teeth have questioned the value of balanced occlusion in eccentric positions.[7,8] When flat plane teeth are balanced at the exact centric position, they are almost of necessity also balanced in the slightly eccentric positions.

The same statement cannot be made for opposing teeth with cusps that mesh. The steeper the cuspal inclines and the more precise the meshing, the greater is the dislodging effect when the teeth occlude in eccentric occlusions. It is because of this

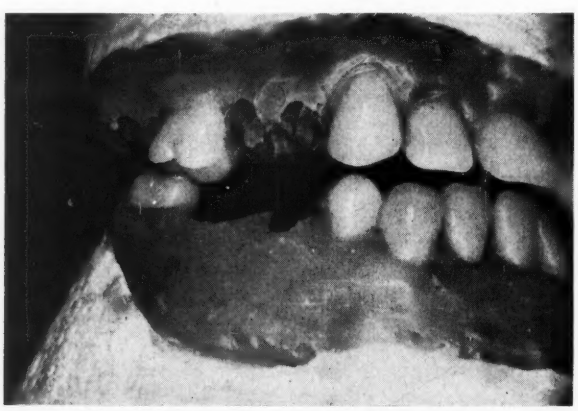

Fig. 2.—Not all of the posterior teeth are necessary to maintain balanced occlusion on the balancing side. The removed teeth are not necessary to ensure balancing contacts.

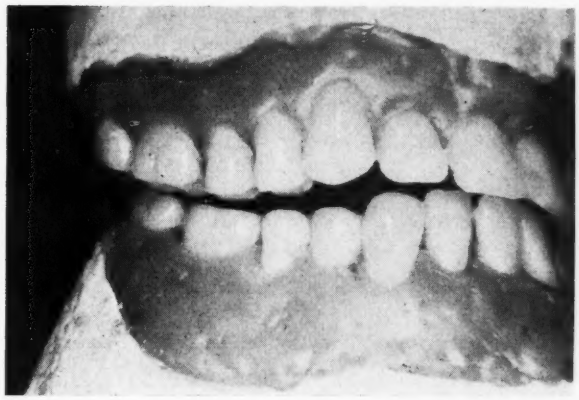

Fig. 3.—With flat plane teeth, the upper bicuspids are not needed for lateral balancing contacts and are arranged to assure greatest denture stability in the working position.

dislodging effect with precisely meshing teeth that the rotary grinder mounted on the articulator assures the patient more comfortable and more stable dentures.[9]

When the clearance produced by the rotary grinder is enough to accommodate the slightly eccentric closures of the teeth in the absence of food, the harmful effects of meshing teeth are partly overcome. The improvement obtained with a rotary grinder is greatest in dentures with tightly meshed steep cusps.

LATERAL BALANCED OCCLUSION

In this discussion, it will be assumed that centric occlusion of the teeth is in harmony with centric jaw relation and that lateral jaw relations produced corresponding lateral tooth occlusions.

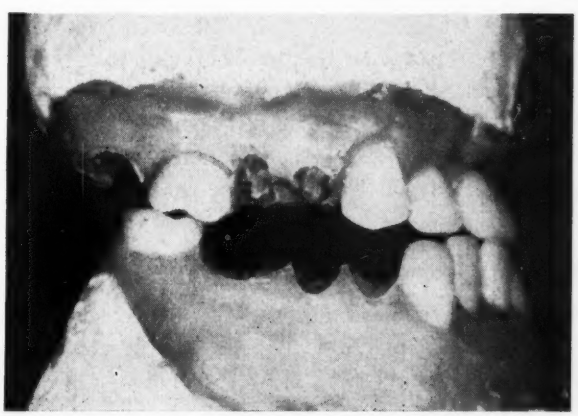

Fig. 4.—The upper bicuspids and the upper second molar, as well as the lower bicuspids and first molar, have been removed to show that a protrusive balancing contact can be obtained without them.

Balanced occlusion in lateral positions is produced by causing some surface on the balancing side to maintain contact while the teeth of the working side are together. With cusp teeth, it has been standard practice to maintain the lingual cusps of all of the bicuspids and molars of the balancing side in contact (Fig. 1). However, this is not necessary. The lower second molar and the upper first molar are the only teeth needed to maintain lateral balancing contacts (Fig. 2).

With *flat plane teeth,* balanced occlusion in lateral positions is assured with the same two molars (Fig. 3). The lower first molar and all of the bicuspids can then be set to their best positions for chewing without having to tilt them at undesirable angles. It is clearly an advantage to set the working surfaces independently of the balancing surfaces so that each tooth can best discharge its function.

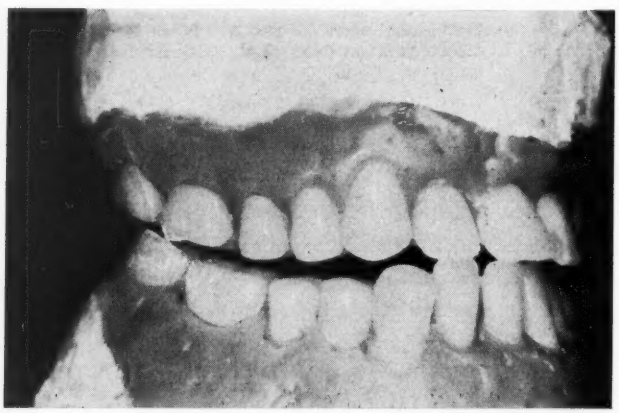

Fig. 5.—Flat plane posterior teeth are set so that the lower second molar and the upper first molar maintain protrusive balancing contact. The other teeth are set independently to assure greatest denture stability when they are in the working positions.

The *upper second molar* should be out of contact in all or nearly all of its occlusal surface. Because occlusal pressure on the *lower second molar* is unfavorable to denture stability except when this tooth is used to produce lateral and protrusive balancing contacts, the upper second molar should ordinarily be omitted or made subocclusal.[10] Omitting the upper second molar makes it possible for the lower second molar to maintain a balancing contact in the protrusive and lateral positions without carrying any of the load at the centric position.

PROTRUSIVE OCCLUSION

The need for balanced occlusion in full protrusion is less imperative than that of the centric and lateral positions. However, this contact is easily obtained with either flat plane or cusp teeth.

Although a protrusive balancing contact in the position of incision is mechanically advantageous, sometimes the full advantage cannot be attained because of conflicting requirements of appearance. When the anterior teeth are set with

considerable vertical overlap for esthetic reasons, it is sometimes not advisable to produce balanced occlusion in full protrusion. The dentist must decide whether to give dominance to esthetics or mechanics. This holds true with flat plane teeth as well as with cusp teeth.

As with balanced occlusion in lateral positions, the key teeth for balanced occlusion in protrusive positions for both anatomic and nonanatomic schemes of occlusion are the lower second molar and the upper first molar. All of the other posterior teeth can be disregarded in this connection (Figs. 4 and 5).

The lower second molars, as they glide on the upper first molars, produce balanced occlusions in all eccentric positions. The lingual tilt of the lower second molar assures a lateral balancing contact, while the anterior tilt produces a protrusive balancing contact.[11,12]

SUMMARY

The problems of occlusion extend into nearly all branches of dentistry. While the principles involved are the same, their application should be different according to the situation. The dentist should not fall into the error of trying to make the same application in all situations.

The examples of orthodontics and prosthodontics show the need for recognizing the similarities and the differences in applying the same principles to different situations. Such recognition should bring about more realistic teaching in the dental schools and more rational procedures in dental practice.

The occlusion for complete dentures should be balanced "at and near" centric jaw relation for protection of the ridges when there is no interposed food. With cusp teeth, this balanced occlusion "at and near" centric relation is obtainable with a rotary grinder. With flat plane teeth, this mechanism is not needed. The occlusion should be balanced at habitual lateral relations used in chewing as well as sometimes in the protrusive position.

Using only the lower second and the upper first molars for establishing lateral and protrusive balancing contacts solves the problem of maintaining balanced occlusion in eccentric positions. At the same time, this method permits the independent arrangement of the other teeth for better direction of the closing force during chewing.

REFERENCES

1. Sears, V. H.: Occlusion: The Common Meeting Ground in Dentistry, J. Pros. Den. **2**:15-21, 1952.
2. Sears, V. H.: Mandibular Condyle Migrations as Influenced by Tooth Occlusions, J.A.D.A. **45**:179-192, 1952.
3. MacMillan, H. W.: Clinical Application of Unilateral Balance to Prosthetic Dentistry, J.A.D.A. **18**:1029-1034, 1931.
4. Moyers, R. E.: Some Physiologic Considerations of Centric and Other Jaw Relations, J. Pros. Den. **6**:183-194, 1956.
5. Sears, V. H.: Suggestions for Accurate Preparation for Plate Work, D. Digest **25**:82-86, 1919.
6. Posselt, U.: Occlusal Relationship in Deglutition and Mastication, Transactions of the European Odontological Society, 1958.
7. DeVan, M. M.: An Analysis of Stress Counteraction on the Part of Alveolar Bone, With a View to Its Preservation, D. Cosmos **77**:109-123, 1935.

8. Kurth, L. E.: Methods of Obtaining Vertical Dimension and Centric Relation: A Practical Evaluation of Various Methods, J.A.D.A. **59**:669-673, 1959.
9. Upp, R. W.: U. S. Patent No. 1,180,745, April 25, 1916.
10. Sears, V. H.: Let's Sink the Upper Second Molar, Cal, March, 1942, pp. 8-10.
11. Sauser, C. W.: Posterior Occlusion in Complete Denture Construction, J. Pros. Den. **7**:456-464, 1957.
12. Nepola, S. R.: Balancing Ramps in Prosthetic Occlusion, J. Pros. Den. **8**:776-780, 1958.

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Modern Equipment Helps Dentists Treat More Patients

High-speed cutting instruments are enabling dentists today to treat more patients in less time and in more comfort, both for dentist and patient, according to the American Dental Association.

Reporting on a newly released survey of dental practice, which was conducted for 1958, the Association said two of every three dentists reported having high- or super-speed cutting instruments.

The instruments are classified in four speeds: low (under 10,000 revolutions per minute), intermediate (10,000 to 30,000 rpm), high (30,000 to 100,000 rpm), and super (over 100,000 rpm). Until after World War II, almost all dentists used low speed.

In the current study, nearly half of the dentists reported using super speeds while two-thirds reported either high or super speeds. Younger dentists tend to use high and super speeds most often.

Concerning the effects of the speeded-up instruments, more than half of the dentists who responded found it enabled them to treat more patients, one-third found it reduced office hours, and a significant number found that it did both. It was also emphasized that patient comfort was greatly increased and dentist fatigue greatly lowered.

ROLE OF THE EXTERNAL PTERYGOID MUSCLES IN TEMPOROMANDIBULAR ARTICULATION

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THE TEMPOROMANDIBULAR ARTICULATION presents a complex arrangement of structures to control the movements of the mandible in respiration, deglutition, phonation, and mastication. The mandible performs many movements of considerable magnitude to assist these vital functions. In phonation, the size of the oral cavity must be enlarged or reduced to modify the vocal tones. The movements of the mandible must accommodate the expressions of the face in laughing, speaking, yawning, and various emotional occurrences. The movements of the mandible also assist in respiration and deglutition.

Since all movements of the mandible are dependent upon the temporomandibular articulation, the magnitude of movement within the joint varies considerably when assisting the functions of respiration, deglutition, phonation, and mastication. The masticatory function is the least important and is used the least. The masticatory movements are the least in magnitude and are a minor function of the temporomandibular articulation.

RESPIRATION AND DEGLUTITION

The functions of respiration and deglutition are present at birth and are in a continuous state of action until death. At birth, the swallowing reflex is present and the mandible assumes a position to maintain an airway. During the period of growth and development, these closely related functions become fixed patterns of neuromuscular movement and continue fixed unless disturbances force a modification.

After the eruption of the permanent teeth, the position of the mandible to maintain airways is coincident with the physiologic rest position. The position of the mandible in deglutition is coincident with centric relation. These positions are usually referred to as nonfunctional. Actually, these positions are vital functional positions of the temporomandibular articulation and, although not functional in the masticatory effort, they must be preserved and given consideration in all denture procedures. Centric relation began as a swallowing reflex at birth and during the period of growth and development became a fixed neuromuscular pattern of movement to assist the function of deglutition. Centric relation is the only fixed dependable position of reference, at which all masticatory movement begins and ends.

CONDYLES AND FOSSAE

The condyles and their interarticular fibrocartilages form an articulation of the mandible with the glenoid fossae of the temporal bones. The articular surfaces of the condyles are convex from the front backward and from side to side. Each condyle is about ¾ inch mediolaterally, about ½ inch anteroposteriorly, and about ¼ inch in vertical dimension. The long axis is directed inward, slightly backward, and downward. The general contour in the sagittal plane closely resembles the shape of one-half of a sphere with the convex surface upward.

The glenoid fossae are elliptic concave depressions of the temporal bones immediately anterior to the auditory canals. The fossae extend about ¾ inch mediolaterally and about 1 inch anteroposteriorly. The anterior portions of the fossae are shall. In the sagittal plane, the roof of the glenoid fossa continues toward and merges with the articular eminence, forming a compound curve which is concave posteriorly and convex anteriorly. The middle part is considered the condyle path that guides the condyle in protrusive and lateral movements of the mandible. Because the upper portion of the fossa accommodates the capsular ligament and the interarticular fibrocartilage, the suspended position of the condyle at centric occlusion is with its superior surface slightly above the lowest point of the eminence. From this position, an extreme opening movement of more than 2 inches in the incisor region is necessary to cause forward movement of the condyles sufficient to spring them over the eminences in a disclocation.

CAPSULAR LIGAMENT

Each condyle, with its interarticular fibrocartilage, is suspended loosely in the glenoid fossa by the four parts of the capsular ligament. The capsular ligament is the only ligament within the fossa and the only ligament directly concerned with movement in the fossa. (The sphenomandibular and stylomandibular ligaments suspend the mandible as a unit from the base of the cranium and function to limit extreme movement of the mandible.)

The capsular ligament consists of bands of fibrous connective tissue and is divided into the anterior, posterior, external lateral, and internal lateral parts. The blending of the fibers of these parts encapsulates the joint. The anterior and posterior parts of the ligament are loose arrangements of fibers which form the inner part of the capsule and allow freedom of action of the condyle within the joint, but limit the extreme forward and backward movements. The anterior part of the ligament is inserted into the anterior margin of the interarticular fibrocartilage and the anterior margin of the condyle. It is attached above to the front part of the articular eminence.

The posterior part of the capsular ligament is inserted into the posterior surface of the ramus of the mandible below the neck of the condyle and is attached above to the margin of the glenoid fissure. The external lateral part of the ligament is attached above to the zygomatic arch and below to the outer surface of the neck of the condyle. Its fibers extend downward and backward from their attachment to the zygomatic arch. The external lateral part suspends the condyle in the fossa and assists in stopping posterior movement of the condyle.

The internal lateral part of the ligament is attached above to the inner margin of the glenoid fossa and to the spine of the sphenoid bone; it is joined below to the inner side of the neck of the condyle. This part of the ligament also functions to suspend the condyle in the fossa.

An analysis of the caspular ligament reveals that the condyle is suspended in the glenoid fossa by the external lateral part of the ligament. The condyle is so suspended that it swings around a horizontal axis at the center of suspension. Therefore, it is my opinion that the center of suspension is a point in the center of the neck of the condyle at the level of suspension and that a line joining these points is the horizontal axis about which the mandible swings. From the average dimensions of the condyle and from the positions of the suspensory ligament, I estimate that the horizontal axis is a point in the center of the neck of the condyle 5 mm. below the transverse center of the condyle.

The theory[1] that the horizontal axis extends through the approximate centers of the two condyles is contrary to the laws of motion. It is axiomatic that the parts of a lever separated by the fulcrum or axis rotate in opposite directions. In an uncontrolled opening movement, the condyle moves forward while the ramus moves backward. The fact that the ramus and the condyle move in opposite directions proves that the axis is below the condyle.

INTERARTICULAR FIBROCARTILAGE

An interarticular fibrocartilage separates each condyle from its fossa. The interarticular fibrocartilage is a crescent-shaped plate of dense, elastic fibrous connective tissue which contains a few cartilage cells. The upper surface of the fibrocartilage is convex and its lower surface concave. The upper surface approximates the shape of the fossa, and the lower surface resembles the upper surface of the condyle upon which it rests.

The interarticular fibrocartilage is attached above to the front of the articular eminence and below to the anterior margin of the condyle by the anterior part of the capsular ligament. The upper head of the external pterygoid muscle also inserts into the anterior margin of the interarticular fibrocartilage and maintains this positional relationship wherever the condyle moves.

The interarticular fibrocartilage completely covers the articular surface of the condyle to its lower edge at the insertion of the anterior portion of the capsular ligament and continues on to the articular eminence. This elastic cushion functions as the protective element of the joint to prevent shock or damage to the condyle, to the fossa, and to the base of the brain. The fibrocartilage moves forward with the condyle in protrusive movement or medially with the condyle in lateral movement, preventing direct contact of the condyle with the fossa.

The relationship of the condyle, the interarticular fibrocartilage, and the fossa precludes any possibility that the condyle is guided by the shape of the fossa. Lateral and protrusive movements begin from centric relation, in which position the condyle is in its most retruded position in the fossa. The condyle can move forward and downward or laterally in the anterior part of the fossa to execute all movements necessary to the functions of respiration, deglutition, and phonation without

coming in contact with the fossa. The minor movements of masticatory function are solely within the fossa, and the shape of the fossa cannot influence the direction of these movements.

EXTERNAL PTERYGOID MUSCLE

The protrusive and lateral jaw movements which are necessary to masticatory function are performed by the external pterygoid muscles. The working limit of mandibular movement in protrusion is the distance which the incisal edges of the mandibular incisors travel from the position of centric relation to bring them against the incisal edges of the maxillary incisors. This is usually a distance of from 1 to 3 mm. The working limit of the mandible in lateral movement is the distance traveled in side movement necessary to bring the buccal and lingual cusps of the lower posterior teeth on the working side directly under and in contact with the corresponding cusps of the upper posterior teeth. This is a distance of about 3 mm. Since these movements originate from the most posterior position that the condyles can assume, since the anteroposterior diameter of condyles is about ¼ inch, and since the fossae are about 1 inch long anteroposteriorly, the magnitude of the lateral and protrusive movements of mastication is executed with the condyles well within the fossae. There is no contact of condyles with the walls of the fossae in function.

The external pterygoids are the only muscles which can produce the protrusive and lateral movements of the mandible. These muscles are responsible for placing the mandible in positions from which the crushing of food is performed by the masseter, temporal, and internal pterygoid muscles when they return the mandible to centric relation.

The external pterygoid muscles are approximately 1½ inches in length and have two origins and two insertions. The upper head of the external pterygoid muscle is flat and arises from the pterygoid ridge of the outer and underneath surfaces of the great wing of the sphenoid bone. Its fibers converge backward, laterally, and downward toward the insertion of the muscle into the anterior surface of the articular capsule and into the anterior margin of the interarticular fibrocartilage. The fibers of this part of the muscle incline downward from their origin at an angle of five degrees toward the insertion. This is at an angle of twenty degrees with the occlusal plane. The fibers also incline outward from the origin at an angle of seventy degrees to the intercondylar line. Thus, the direction of force of the upper part of the muscle is on a line from the insertion upward and forward to the origin at an angle of five degrees above the horizontal plane and medially at an angle of twenty degrees.

The lower head of the external pterygoid muscle is rounded from its origin on the outer surface of the external pterygoid plate of the sphenoid bone, on the pyramidal process of the palatine bone, and on the tuber maxillare of the maxillary bone. The fibers of the lower part of the muscle converge backward, laterally, and upward to the insertion in the pterygoid fovea on the anterior surface of the neck of the condyle. The lower part of the external pterygoid muscle extends upward from its origin at an angle of thirty-five degrees to the horizontal plane and at an angle of twenty degrees to the occlusal plane. It extends laterally at an angle of fifty

degrees to the intercondylar line. The direction of force of the lower part of the muscle is on a line from the insertion downward at an angle of thirty-five degrees and medially at an angle of forty degrees. The resultant force of the two parts of the external pterygoid muscle acts at an angle of fifteen degrees below the horizontal plane, which is coincident with the ala-tragus line and parallel to the occlusal plane.

The direction of protrusion is dependent upon the resultant force exerted by the pair of external pterygoid muscles when both muscles contract simultaneously. Although the resultant force applied by each individual muscle is at an angle of fifteen degrees downward and at an angle of thirty degrees medially from its point of insertion, the medial inclinations nullify each other and produce a glide in the direction of the force of the two parallel components. These components retain their original forward direction with a downward inclination of fifteen degrees below the horizontal plane. Protrusion is pure translation because all parts of the moving mandible have at each instant the same direction and velocity.

LATERAL MOVEMENT

Lateral movement is produced when only one external pterygoid muscle contracts. The force of the upper part of the muscle acts at an angle of twenty degrees from its insertion toward the midline, and the lower part acts at an angle of forty degrees from its insertion toward the midline. The resultant force of the two parts of the muscle acts at an angle of thirty degrees from its insertion toward the midline. When one muscle contracts, the point of insertion on that side moves forward parallel to the occlusal plane and medially at an angle of thirty degrees. This forces a lateral displacement of the opposite point of insertion and a displacement of the lower median incisal point. This displacement or side shift of the mandible varies with the distance between the points of insertion of the muscles, with the distance from the points of insertion to the lower median incisal point, and with the magnitude of movement. Because all points of the moving mandible in lateral motion do not have the same direction, this motion is not translation in the mechanical sense but is a displacement.

SUMMARY

An analysis of temporomandibular articulation reveals that:

1. The interarticular fibrocartilages prevent direct contact of the condyles with the surfaces of the fossae during all mandibular movements. This precludes any possible condylar guidance by the shape of the bony fossae.

2. Physiologic rest position is a definite mandibular position which maintains airways and is controlled by the neuromuscular system.

3. Centric relation is a definite mandibular position which is assumed in the function of deglutition. This position is the starting point of all mandibular movement, because the mandible continually returns to this position in the course of the swallowing reflex.

4. Lateral mandibular movement is a rectilinear movement forward toward the midline and parallel to the occlusal plane. This movement is not translation.

5. Protrusion of the mandible is a rectilinear forward movement parallel to the occlusal plane. Protrusion is translation.

6. The horizontal axes of certain mandibular movements are in the necks of the condyles.

7. The Bennett movement is the lateral shift of the mandible coincident with lateral mandibular movement.

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REFERENCE

1. Sicher, Harry: Oral Anatomy, ed. 3, St. Louis, 1960, The C. V. Mosby Company, p. 170.

REMOVABLE PARTIAL DENTURES

ADAPTATION OF RUBBER-BASE IMPRESSION MATERIALS TO REMOVABLE DENTURE PROSTHETICS

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THE CLINICAL USE of the polysulfide rubber–base materials† as impression media for removable prostheses has received comparatively little attention. Bailey,[1] Dresen,[2] and Freese[3] have published their observations. The manufacturers make little mention of this use beyond saying it can be used for complete and partial denture impressions.

Investigations to determine the physical properties of rubber-base material have been published by Hollenback,[4] Myers,[5] Clark,[6] Phillips,[7] Schnell,[8] Fairhurst,[9] and Skinner[10-12] and their associates. They show this material is dimensionally unstable, but if handled correctly its shortcomings can be overcome. By applying this information, progress was made from haphazardly successful results to the consistent production of adequate complete, partial, and relining impressions. Adequacy was determined according to the requirements of an impression as stated by Boucher,[13] Fisher,[14] and Roberts.[15] The progress was the result of the gradual development of a technique based on the physical behavior of this material, the selection of usable brands of the material, and handling the material so as to counteract the effects of dimensional instability.

TESTS OF PHYSICAL PROPERTIES

The following properties of the dental polysulfide rubber impression materials have been studied[4-12]: (1) dimensional stability, (2) elasticity, (3) consistency and flow, (4) manipulation and setting time, (5) percentage of strain and percentage of set, and (6) behavior in storage. The standards used for testing were those of A.D.A. Specification No. 11 for hydrocolloid, there being no standard yet established for the polysulfide rubber material.

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DIMENSIONAL STABILITY

Each of the investigators reported that the rubber-base material is dimensionally unstable in strict interpretation and, in general, that its behavior is erratic. On the other hand, all of them said accurate castings could be made repeatedly *if the materials are handled correctly.* Phillips[7] observed, "It is apparent that the accuracy of the rubber base materials is in the same realm as reversible hydrocolloid, and that this class of impression material may be considered satisfactory for routine indirect techniques of a complex and meticulous nature. Lack of clinical success can only be attributed to improper manipulation and use of the material." Skinner and Cooper[10] stated, " . . . The dimensional stability of the rubber impression material is very good, provided that the proper technique has been used. Certainly, these materials are superior to hydrocolloid impression materials in this regard."

Skinner[11] declared he observed no significant dimensional change in these materials in the first 30 minutes of set. Schnell and Phillips[8] showed that about 25 per cent to 40 per cent of dimensional distortion occurs within the first hour of set.

DISTORTION CAUSED BY PROPORTIONING, MIXING, AND SETTING TIME

These manipulative procedures have a great deal of influence upon the elastic properties, the percentage of strain, and the percentage of set of rubber-base materials. Manufacturers recommend proportions of one to one accelerator to base and a mixing time of 45 seconds. Both instructions should be adhered to strictly. Strangely enough, varying the proportion of accelerator does not advance or retard the setting significantly for some brands, but unpredictably it may render the mix tacky and weak. A drop or two of one of the fatty acids (oleic acid) will retard the setting time. The addition of a couple of drops of water will accelerate the setting time.

Mixing for more or less than 45 seconds causes wide variations in the percentages of strain and of set. But, adhering to the recommended mixing time produces set and strain values for most polysulfide rubber impression materials that are within the limits of A.D.A. Specification No. 11.*

During the initial polymerization period, the elastic properties are being developed. Most of the manufacturers' instructions state that adequate elasticity has developed for removal of the impression from the mouth in 6 minutes. However, Fairhurst and associates[9] found that the strain value was improved to 61 per cent and the set value was improved to 98 per cent when the material was allowed to set in the mouth undisturbed for an additional 4 minutes.† Therefore, to minimize distortion, it is important *not* to remove the impression from the mouth in 6 minutes but to allow a full 10 minutes after the start of the mix before removing it.

*Four per cent minimum to 20 per cent maximum for strain; 3 per cent maximum for permanent set.

†Calculated from Table II in reference 9.

DISTORTION RESULTING FROM SHRINKAGE AND STORAGE

The set of the mixture of base and accelerator is accomplished by polymerization, which continues at a diminishing rate for at least 24 hours and is accompanied by shrinkage. Thus, an oversize cast is produced because the direction of shrinkage is toward the tray to which the material is attached with a rubber adhesive.

Hollenback[4] determined that the shrinkage is of the order of 0.025 to 0.030 per inch. This amount is small, and most investigators agree that the shrinkage factor is insignificant in distortion.

The most important factor in preventing distortion is complete coverage of the tray with an adhesive, which must be allowed to dry before the polysulfide rubber mixture is applied. The material will not stick to anything except the adhesive or itself. If any of the material does not stick to the tray, distortion occurs.

While behavior in storage before the cast is poured is erratic and storage is to be avoided if possible, the finished impressions should be stored in air only. Storing in water or 100 per cent humidity warps the acrylic resin tray. A plastic impression tray should never be used because the plasticizer in the polysulfide rubber warps the impression plastic.

Some manufacturers recommend storing the impression for 45 minutes before the cast is poured, to allow the elastic properties to develop. Some investigators suggest pouring the cast immediately, and others say a 2 hour delay will do no harm. However, since as much as 40 per cent of the total distortion may occur in the first hour, the cast should be poured within 30 minutes.

Skinner and Cooper[10] found that artificial stone casts poured against rubber-base material set as hard or harder than those poured against reversible or irreversible hydrocolloid. Mixing the artificial stone in a vacuum is an aid in producing a dense cast.

QUALITY OF FLOW

The flow of rubber-base materials is variable because it is dependent on consistency and setting time, which may be altered by humidity, temperature, and time of insertion into the mouth. The flow, in general, is comparable to or better than that of zinc oxide and eugenol paste, greater than that of alginate (irreversible hydrocolloid), and far greater than that of plaster of Paris.

Myers, Wepfer, and Peyton[5] compared the consistency of twelve brands of rubber-base materials by measuring the diameter of a disk of material flattened between two glass plates under a standard weight for 10 minutes. The diameter of each disk of material was expressed in millimeters from 12 to 34. Clinically, those with values below 25 are unusable for this purpose. They either set too rapidly, flowed sluggishly, required pressure, or were so resistant to molding by tissues that overextened, wide borders resulted. Some of these materials are the more dimensionally stable, as indicated by their percentage of permanent set. However, most advantages seem to favor a live, free-flowing material. Therefore, the regular types, with a value of at least 25, and the injection type, with a value of 30 or over, are preferred. With their longer setting time and greater

flow, they require practically no pressure for adaptation and registration of detail and are easily molded by functioning tissues. Paired brands, a regular material and a light-bodied material, are furnished by the same manufacturer and can be used singly or together.

DISADVANTAGEOUS FACTORS

The following factors produce dimensional instability of the rubber-base materials: (1) continuous polymerization, (2) release of internal strains, (3) use of an impression plastic tray, (4) insufficiency of adhesive and failure to allow it to dry, (5) an incorrect mixing time, (6) variation in the ratio of the accelerator to the base, (7) a material thickness of more than 2 to 3 mm., (8) interference with the development of the elastic properties by making the impression after the material has started to set or by removing the impression from the mouth before 10 minutes has elapsed from the start of the mix, (9) storage of the impression for more than 30 minutes in air or storage in water, and (10) failure to pour the cast immediately.

There are certain procedures which will minimize the disadvantageous factors or completely nullify them. A set of rules for handling rubber-base materials for removable prosetheses are: (1) use only an acrylic resin tray, (2) use a minimum spacer or no spacer, (3) use a one to one proportion of accelerator to base, (4) mix for exactly 45 seconds, (5) apply a good covering coat of adhesive and allow it to dry thoroughly, (6) carry the loaded tray to the mouth immediately, (7) allow a full 10 minutes from the start of the mix before removing the impression from the mouth, (8) store the finished impression only in air for a minimum length of time, (9) box the impression, and (10) pour the cast immediately.

TECHNIQUE

An impression is no better than the tray used to make it. This is especially true of viscous impression materials such as plaster of Paris, zinc oxide and eugenol paste, and irreversible and reversible hydrocolloids. The polysulfide rubber material is a viscous liquid and requires a carefully made confining tray in order to make an adequate impression.

TRAY CONSTRUCTION

An acrylic resin tray is made directly on a cast poured in an alginate impression. Space is created over the crest of the mandibular ridge and sharp mylohyoid ridges by removing material from the tray. Holes are cut for the escape of excess impression material. The labial and buccal borders of both trays are reduced 2 mm. from the tissue reflections. The finished impressions are boxed. The alternate method of double pouring of casts is satisfactory, but inverting the impression onto some of the artificial stone is fraught with the danger of mechanical distortion and a loss of adaptation of the cast material to the impression.

TREATMENT OF COMPLETE UPPER TRAY

The posterior border of the upper tray is cut short of the vibrating line. Impression plastic is placed on this border, and the border is shaped by Kile's

method,[16] modified by having the patient draw on the dentist's finger as though smoking. Then, zinc oxide and eugenol paste is placed on the entire border and postpalatal seal area, and the tray is seated. When the patient draws on the dentist's finger, all borders are molded. Upon removal of the tray, all spots where the tray shows through are cut down with a No. 2 flame-shaped bur. Rubber cement is applied to the impression surface, the borders, and 4 mm. of the adjacent buccal and labial flange and allowed to dry.

THE MAXILLARY IMPRESSION

Two applications of the light-bodied (injection type) polysulfide rubber impression material are used to complete the maxillary impression. Three inches each of base and accelerator are mixed with a wide blade plaster spatula on a large mixing pad for exactly 45 seconds. The material is spread evenly and thinly over the adhesive with a small cement spatula. The tray is inserted into the mouth as soon as possible and lightly, but steadily, seated while counting to five slowly. Then, the tray is held in place with just enough support to prevent dislodgment while the patient draws lightly on the dentist's finger as in smoking. The drawing maneuver is repeated every 30 to 45 seconds until the initial set occurs in 3 to 4 minutes. Then the finger is withdrawn. The patient is told to relax with the lips in light contact and to swallow often to repeatedly seat the impression.

After 10 minutes from the start of the mix, the impression is removed. Spots where the zinc oxide and eugenol paste or the tray shows through the rubber are reduced, and adhesive is applied. Extensions of rubber behind the posterior border of the tray and any unnatural border width resulting from uneven distribution of material are reduced with a knife or scissors. The second mix is painted all over the first impression with a stiff bristle mucilage brush. The same maneuvers trim this application, and it is left in the mouth 10 minutes. The impression is boxed and the cast poured immediately.

RATIONALE FOR HANDLING MAXILLARY IMPRESSION

The zinc oxide and eugenol paste border is formed because the light-bodied rubber impression materials need close support. Mixing is concluded at exactly 45 seconds because more or less time alters the strain and set properties adversely and weakens the elastic properties. The second layer is painted onto the first layer of the material to assure an even, thin coating. This will promote accuracy by compensating for shrinkage, registering detail, and enhancing adaptation. The tray is carried to the mouth immediately after loading to reduce distortion caused by making the impression after the initial set may have begun. A posterior palatal seal is carved in the cast only to compensate for the warpage of the acrylic resin. Palatal relief is not necessary because the excellent flow and long setting time apparently equalizes the pressure on the hard and soft tissues. It is rarely necessary to relieve a fulcrum point in the denture.

FORMING THE LINGUAL BORDER OF THE MANDIBULAR TRAY[17]

The lingual, retromylohyoid, distal, and distobuccal borders are handled in the following manner. An unaltered denture pressure spot detector cream is piled on

the border of the flange to be tested, the tray is inserted, and functional movements are made by the patient. The tray is removed and the borders that show through the detector cream are reduced and the border is tested again. The flange is the correct length when a well-rounded pile of detector cream is molded on the border without exposing the tray.

The borders are trimmed in four sections on each side. The distobuccal border, as influenced by the masseter muscle, and the distal border, as influenced by the pterygomandibular raphe and temporal tendon, are trimmed simultaneously by directing the patient to open the mouth widely, then elevate the mandible against the pressure of the dentist pushing downward on the tray.

The retromylohyoid curtain and superior constrictor regions are trimmed by having the patient protrude the tongue and then, as a second maneuver, by swallowing.

The border in the mylohyoid region is tested by having the patient place the tip of the tongue in the opposite cheek. This movement sometimes removes the detector cream from the inner side of the flange. The flange should be beveled so as to give a desirable horizontal extension. Swallowing, to lift the floor of the mouth, is used also for this border.

The lingual frenum and lingual sulcus regions are trimmed by having the patient place the tip of the tongue in the maxillary labial vestibule and swipe the inside of the upper lip from cuspid to cuspid.

Usually, an undercut must be blocked out on the cast in the retromylohyoid fossae when the tray is made. This blocked out part of the tray is restored with impression plastic.

Zinc oxide and eugenol paste is placed on all borders and molded with the same movements that were used in border molding. The exposed tray is reduced.

THE MANDIBULAR IMPRESSION

Two applications of polysulfide rubber are used for the lower impression. The first application is of "regular" consistency material, and the second is of "light-bodied" material. The lingual borders are trimmed by the same tongue and swallowing movements that were used in trimming the resin tray. Repeated swallowing is all that is used to mold the labial and buccal borders.

The first impression remains in position for 10 minutes, it is removed, and the pressure spots are relieved. Extensions of the excess material which was squeezed beyond the tray border by the tongue and mandible in the retromylohyoid space can be trimmed away with a scissors or knife. Wide borders on the buccal side are trimmed away. The second application of the rubber-base impression material is painted on with the mucilage brush, and the tray is inserted and left in place 10 minutes. The finished impression is boxed and the cast is poured immediately.

RATIONALE FOR HANDLING THE MANDIBULAR IMPRESSION

The reasons for and objectives of handling the material for the mandibular impression are the same as those given for the maxillary impression. However, the

regular consistency material performs better as the first application. This may be true because of the difference in the direction in which the impression is seated, the difference in the size and shape of the ridge, and the relative activity and strength of the border tissues during border molding.

IMPRESSIONS FOR REMOVABLE PARTIAL DENTURE

An individual acrylic resin tray is made on a study cast. A spacer of one thickness of baseplate wax is placed over all teeth, but the tray is made directly against the posterior edentulous ridges. The borders of edentulous spaces are trimmed as for a complete denture. The dentulous part of the tray is trimmed back so only the teeth and any parts of the gingival surfaces that are needed on the cast are covered.

Phillips[8] states that the double mix technique increases the accuracy of the impression. So, light-bodied impression material is placed around the teeth with a syringe and spatula. Then, a tray filled with regular material is seated and allowed to set 10 minutes.

It is essential that an individual tray be made to reduce the chance for distortion. A layer of rubber-base material that is either too thick or of variable thickness increases the danger of distortion.

RELINING

While a relining procedure is none too satisfactory from any standpoint, it must be done in certain circumstances. The use of a thin layer of rubber-base impression material is ideal for this purpose. Escape holes made through the labial flange aid in preventing the maxillary denture from moving forward. The crest of the mandibular ridge is relieved by grinding, and escape holes are placed in the denture. The entire tissue surface of both dentures is freshened with a bur. The borders and the application of the impression material are handled similarly to the methods used for the maxillary and mandibular impressions.

The occlusal relationship is preserved by finishing the maxillary relining impression first so it will control the position of the mandibular denture. Since a closed mouth technique is used, the patient must be cautioned not to close with much force, but only to tap lightly, spit, swallow, maneuver the tongue, tap again, and draw on a glass tube.[16] Too much occlusal pressure will squeeze most of the impression material out of the dentures. The result will be many pressure points and the necessity for adding another application of impression material.

ADJUSTMENTS

Denture adjustments must be differentiated between those made necessary by occlusion and those made necessary by inadequacies of the impression. Adjustments necessitated by inadequacies of rubber-base impressions are very few. When adjustments are necessary, overextensions on the lower denture border at the labial frenum and the buccal pouch region are most frequent. Occasionally, a fulcrum in the palate must be relieved.

CONCLUSION

Some investigators believe that the polysulfide rubbers are universal impression materials.[9] Some of these materials are adequate from a clinical standpoint for impressions for removable prostheses when they are handled properly. However, the material can be easily abused. The material must be handled at least as carefully as described. Any less care or the use of a more simplified procedure results in inadequate impressions. The main disadvantage of this material is its dimensional instability. This shows up in some dentures fabricated from impressions which are carelessly made. The main advantage of the material is its live flow.

SUMMARY

A clinical evaluation of the adaptability of some of the polysulfide rubber–base impression materials for use in procedures for making removable prostheses has been given. A technique for handling the material to produce adequate impressions has been presented.

REFERENCES

1. Bailey, L. R.: Rubber Impression Technic for Complete Dentures, J. Indiana D. A. **37**:8-11, 1958.
2. Dresen, O. M.: The Rubber Base Impression Materials, J. Pros. Den. **8**:14-18, 1958.
3. Freese, A. S.: Stable Occlusion Rims With Rubber Impression Material, J. Pros. Den. **6**:756-757, 1956.
4. Hollenback, G. M.: A Study of the Physical Properties of Elastic Impression Materials and Stones, J. South. California D. A. **25**:20-28, 1957.
5. Myers, G. E., Wepfer, G. G., and Peyton, F. A.: The Thiokol Rubber Base Impression Materials, J. Pros. Den. **8**:330-339, 1958.
6. Clark, R. J., and Phillips, R. W.: Flow Studies of Certain Dental Impression Materials, J. Pros. Den. **7**:259-266, 1957.
7. Phillips, R. W.: Elastic Impression Materials—A Summary of a Recent Conference and Analysis of the Current Status and Recent Research, J. South. California D. A. **25**:28-33, 1957.
8. Schnell, R. J., and Phillips, R. W.: Dimensional Stability of Rubber Base Impressions and Certain Other Factors Affecting Accuracy, J.A.D.A. **57**:39-48, 1958.
9. Fairhurst, C. W., Furman, T. C., Schallhorn, R. V., Kirkpatrick, E. L., and Ryge, G.: Elastic Properties of Rubber Base Impression Materials, J. Pros. Den. **6**:534-542, 1956.
10. Skinner, E. W., and Cooper, E. N.: Desirable Properties and Use of Rubber Impression Materials, J.A.D.A. **51**:523-536, 1955.
11. Skinner, E. W.: Use and Criteria of Selection of Rubber Impression Materials, Ann. Den. **16**:79-91, 1957.
12. Skinner, E. W.: The Properties and Manipulation of Mercaptan Base and Silicone Base Impression Materials, D. Clin. N. America, November, 1958, pp. 685-697.
13. Boucher, C. O.: Impression Building, D. Survey **22**:2062-2068, 1946.
14. Fisher, R. D.: Six Fundamental Rules for Making Full Denture Impressions, J. Pros. Den. **1**:135-144, 1951.
15. Roberts, A. L.: Principles of Full Denture Impression Making and Their Application in Practice, J. Pros. Den. **1**:213-228, 1951.
16. Kile, C. S.: Full Denture Impressions, J. Pros. Den. **4**:319-326, 1954.
17. Chase, W. W., and Vig, R. G.: Tray Preparation for Functional Trim of the Complete Lower Impression, D. Digest **65**:70-72, 1959.

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FIXED PARTIAL DENTURES

ANTERIOR VENEER CROWNS WITH GOLD BACKINGS

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AN ANTERIOR VENEER CROWN can be made by attaching a flat lingual backing to a gold coping. The backing is attached to the linguogingival margin and the linguoincisal edge of the coping. Two inclined posts are attached at each side of the mesial and distal corners of the coping. The posts terminate at the inner incisal corners of the backing.

Acrylic resin covers the entire labial, mesial, and distal surface of the coping, as well as the entire lingual surface inside the channel produced by the backing. The resin also passes through the triangles formed by the two posts at each side of the mesioincisal and distoincisal corners of the coping. This gives the resin the adequate anchorage and durability. It also provides the most esthetic appearance.

This crown can be used as a single unit or as an abutment for a fixed partial denture. The crown is easily adaptable to fixed partial dentures when the pontics are made with gold backings.

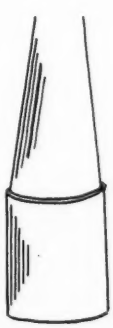

Fig. 1

Fig. 2

Fig. 3

Fig. 1.—An impression is made of the prepared tooth in a copper tube.
Fig. 2.—A stone die is constructed.
Fig. 3.—The wax is removed from the gingival margin of the wax coping.

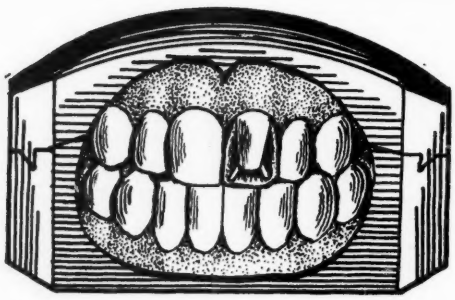

Fig. 4.—The die is mounted on the articulator and a lingual backing is waxed.

TECHNIQUE

The tooth is prepared for a full crown, an impression is made in a copper tube, and a stone die is constructed (Figs. 1 and 2). The die is placed in water and left until it is completely saturated. The surplus water is removed, and the die is dipped in molten wax and withdrawn instantly to form a wax coping. The wax coping is trimmed at the gingival margin and removed (Fig. 3).

The die and coping are placed in a cast which has been mounted on an articulator. Two thicknesses of 28 gauge green sheet wax are added to the gingival margin of the wax coping. The green sheet wax is cut to the size of the lingual surface of the tooth, molded to overlap the lower incisors, and united with the incisal edge of the wax coping. This union leaves a space between the incisal edge and the linguogingival border of the wax coping (Fig. 4).

Fig. 5

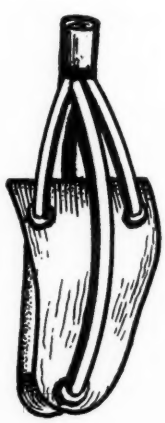

Fig. 6

Fig. 5.—Two wax posts extend from the backing to the inner surface of the coping.
Fig. 6.—The coping and backing are sprued.

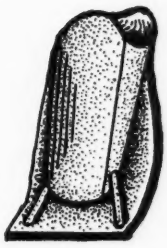

Fig. 7

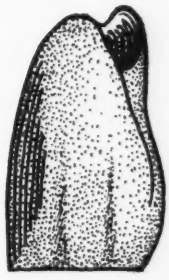

Fig. 8

Fig. 7.—The labial surface of the coping is covered with opaque resin.
Fig. 8.—The waxing of the crown is completed.

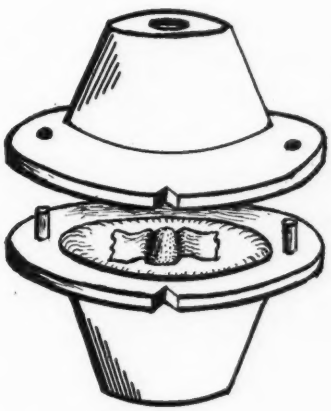

Fig. 9.—The crown is flasked.

Fig. 10.—The completed crown.

Two wax posts are added at each side of the lower part of the wax backing. The posts extend to the inner surface of the wax coping (Fig. 5). The coping and backing are sprued, invested, and cast (Fig. 6).

The labial surface of the crown is covered with an opaque resin material (Fig. 7), and the labial surface of the crown is molded in wax (Fig. 8). The waxed-up crown is invested in a flask (Fig. 9), boiled out, packed, cured in acrylic resin, and finished (Fig. 10).

CONCLUSION

A crown made by this method is esthetic. It also resists abrasion and can serve as an abutment for a fixed partial denture.

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AN EVALUATION AND COMPARISON OF PORCELAINS FUSED TO CAST METALS

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THE DESIRE OF DENTAL PATIENTS for more cosmetic restorations is undeniable. Indeed, many patients are more interested in the esthetic appearance of the restorations than any other feature of dental service and demand dental rehabilitation that will make them look and feel better.

Along with this revolution emerged the renaissance of porcelain as a useful material. To meet the requirements of the fixed partial denture, porcelain was fused to a cast-metal understructure. This was a definite advance over other fixed partial denture techniques, since these materials seemed to satisfy most of the dental and esthetic requirements.

As porcelain gained popularity, more and more variations of basic materials, as well as concepts, were offered to the profession. The contentions of the manufacturers were enthusiastic, often beyond realism. The profession had no information concerning these procedures, and all queries were met with vague and obtuse answers. We did not know what the basic materials were and what physical properties they possessed. Even if the physical properties were known, there was no means for comparison, since we had no standards for these materials.

In an effort to eliminate this confusion, the more accepted "porcelain fused to metal" techniques were tested and evaluated. Although this work is only the beginning of much needed research, these tests proved enlightening and the results were revealing.

CAST METAL AND FUSED PORCELAIN TECHNIQUES

Two basic concepts of cast metal–porcelain techniques are used in dentistry. They will be referred to as A and B. In type A, porcelain is fused to the platinum palladium group of alloys—the "high-fusing" techniques. By type B, porcelain is fused to gold alloys—the "low-fusing" techniques.

Each technique has its own set of components, i.e., a casting metal, solder, opaque, incisal and body porcelains, and stains. Their properties, advantages, and disadvantages will be discussed. Clinically, however, the indications, preparations, impressions, and cementation procedures are the same for all techniques.

In the type A, or high-fusing, groups, Permadent 27, 10 per cent iridium and platinum with Apco porcelain, and Micro-Bond were tested. In the type B, or low-fusing, techniques, only Permadent 22 and Improved Ceramco were evalu-

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ated, since all low-fusing techniques were quite similar. The comparison of these two low-fusing techniques to the high-fusing ones seemed amply to cover the B category.

METALS

The metals were tested in three categories and then compared to type C gold, which is commonly used for this type of restoration. The physical properties of type C gold cannot be considered adequate for the metal-porcelain type of restoration. Type C gold used for an all-gold casting, or in conjunction with processed plastic, is strong and rigid enough to withstand functional oral stresses. For porcelain fused to cast metal in fixed partial dentures, however, the metal structure should be as rigid as possible. If the understructure should bend or "give" in function, even just enough to compensate for an undercut in a preparation (as it might in combination gold and plastic restorations), the porcelain will fracture. Therefore, the following rule has become obvious: the more rigid the metal understructure, the less likely the porcelain is to fracture.

The physical properties of the various metals are shown in Table I. The proportional limit indicates the relative resistance to permanent deformation or bending. The measurements of tensile or ultimate strength indicate the load required to actually break a specimen. The Brinell hardness number indicates the resistance to indentation. Specimens were tested after the firing cycle.

TABLE I. PHYSICAL PROPERTIES OF METALS

METAL	PROPORTIONAL LIMIT (P.S.I.)	TENSILE STRENGTH (P.S.I.)	BRINELL HARDNESS NUMBER
Type C casting gold	33,500*	70,000*	128*
Ten per cent iridium and platinum	22,200†	52,700†	105†
Permium 27 alloy	29,500‡	62,400‡	125‡
Premium 22 alloy	13,400‡	42,000‡	75‡
Micro-Bond alloy	47,300‡	85,000‡	162‡
Improved Ceramco gold No. 1	20,900‡	31,800‡	89–90‡

*Bureau of Standards, Washington, D. C.
†Engelhard Industries, Newark, N. J.
‡New York Testing Laboratories, Inc., New York, N. Y.

All of the metals tested are readily workable in the laboratory. The B class of metals (gold alloys) are easier to cast than the A class of metals. The B class of metals may be cast with the investments, burnout equipment, and casting apparatus normally used for gold. The higher fusing A class of alloys requires more elaborate investing, burnout, and casting procedures because of the higher melting range of the metal. Cutting, grinding, and finishing of these metals are done with standard burs and stones.

PORCELAINS

The specially compounded porcelains used in conjunction with the cast-metal understructures are usually feldspar-base porcelain. These porcelains, like other dental porcelains, are nontoxic and insoluble in mouth fluids, and they are very compatible with the oral tissues. Porcelains are poor conductors and, therefore, are excellent insulators for the abutment teeth against thermal and electrical shock. Porcelain does not add strength to the physical properties of the underlying metal structure. The porcelain is used to satisfy the esthetic requirements only and, hence, is only a veneer or "cosmetic" cover.

TABLE II. PHYSICAL PROPERTIES OF PORCELAINS

PORCELAINS	FUSING TEMPERATURES	TRANSVERSE STRENGTH (P.S.I.)	IMPACT STRENGTH (INCH-OUNCES)	ROCKWELL C HARDNESS
Ceramco	1,800° F.*	725	6.50	47–51
Apco	1,875° F.*	794	6.44	66
Permadent 2,100° F.	2,100° F.*	587	4.98	63
Permadent 1,800° F.	1,800° F.*	480	4.41	64
Micro-Bond	2,000° F.*	847	8.00	62
Tooth enamel				35–39.5†

*Manufacturers' specifications.
†Converted from the Knoop scale.

All of the metals tested had a specially compounded porcelain designed to fuse to them. The 10 per cent iridium and platinum alloy is an exception. It is most often used in conjunction with Apco 1,875° F. porcelain. Therefore, Apco 1,875° F. porcelain is included in the following tests (Table II). For the test of transverse strength, the specimen is suspended on both ends and a load is applied to the center until the specimen breaks. Tests of impact strength determine the resistance a material offers to stress concentration. The resistance is measured in inch-ounces. Because dental porcelains are very hard in comparison to metals, the Rockwell C scale was used rather than the Brinell test used in the metal testing. To create a basis for comparison, dental enamel is included in this scale.

All porcelains tested were very much harder than tooth enamel. Therefore, it would appear that porcelain would wear normal tooth structure during contact. Clinical experience has shown that this was not a problem if the porcelain surfaces that contacted natural tooth enamel were well polished or glazed and if the occlusion was well balanced. In many instances where gold restorations opposed a porcelain restoration, particularly in the posterior part of the mouth, the gold restoration showed dramatic wear while the porcelain restoration remained intact.

All porcelains tested were easily workable. They all possessed good handling properties. The color values were good and showed little evidence of burnout or fading during the normal firing cycles. The porcelains that fused above 1,875° F.

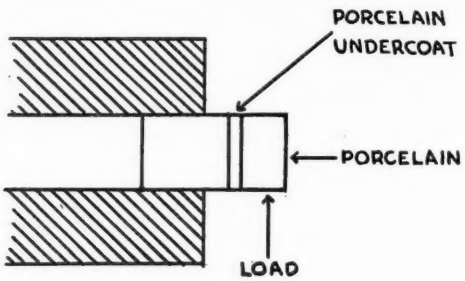

Fig. 1.—Porcelain-metal bonding test with a ¼ by ¼ by ½ inch alloy bar. The apparatus measures the load necessary to *break* the bond between the metal and the porcelain (pounds per square inch).

were the materials with the most technical latitude. They can be stained, corrected, reglazed, and overglazed more readily than the lower fusing porcelains. They can be fired more often with less detrimental effect on the basic structure of the porcelain.

COMBINATIONS OF PORCELAINS AND METALS

The porcelains, when fused to their related metal understructures, take on the strength or the weakness of their underlying frames. Therefore, tests on the combinations of the various porcelains and metals proved the most critical and revealing. These tests indicate the strength and durability of a finished restoration.

MATERIALS TESTED

The combinations of materials tested were (1) 10 per cent iridium and platinum and Apco 1,875° F. porcelain, (2) Permium 27 alloy with 2,100° F. Permadent porcelain, (3) Permium 22 alloy with 1,800° F. Permadent porcelain, (4) Micro-Bond alloy and regular Micro-Bond porcelain, (5) Micro-Bond alloy and vacuum Micro-Bond porcelain, and (6) Improved Ceramco gold and Ceramco porcelain.

TABLE III. STRENGTH OF THE BOND

BONDED MATERIALS	P.S.I.
Ten per cent iridium and platinum and Apco 1,875° F. porcelain	1,561
Permium 27 with Permadent 2,100° F. porcelain	2,360
Permium 22 with Permadent 1,800° F. porcelain	630
Micro-Bond alloy with regular Micro-Bond porcelain	3,280
Mirco-Bond alloy with vacuum Micro-Bond porcelain	3,330
Improved Ceramco gold with Ceramco porcelain	2,347
Improved Ceramco gold with vacuum Ceramco porcelain	2,985

THE PORCELAIN-METAL TEST

No testing apparatus for measuring the bond between a fused porcelain and its related metal existed. Therefore, a test was devised (Fig. 1). The opaque undercoat and porcelain were baked to a metal bar having the dimensions of ¼ by ¼ by ½ inch. The bar was held in a vise and a load was applied to the porcelain. The force needed to *break* the porcelain from the metal was recorded and these values are shown in pounds per square inch (Table III).

In vacuum firing, the density of the porcelain that is in contact with the metal undersurface, being free of air pockets and other voids, produces a larger surface contacting the metal structure. Therefore, the resultant adhesion is greater. If the other systems would develop a porcelain that is effective for a vacuum-firing technique, the resultant bonds would improve in this very critical test.

IMPACT STRENGTH OF PORCELAIN FUSED TO CAST-METAL UNDERSTRUCTURE

Since no adequate device for this test existed, a modified *falling ball test* was devised (Fig. 2). A calibrated plastic tube is placed over the specimen to be evaluated. The test crowns have standard dimensions and they fit the supporting

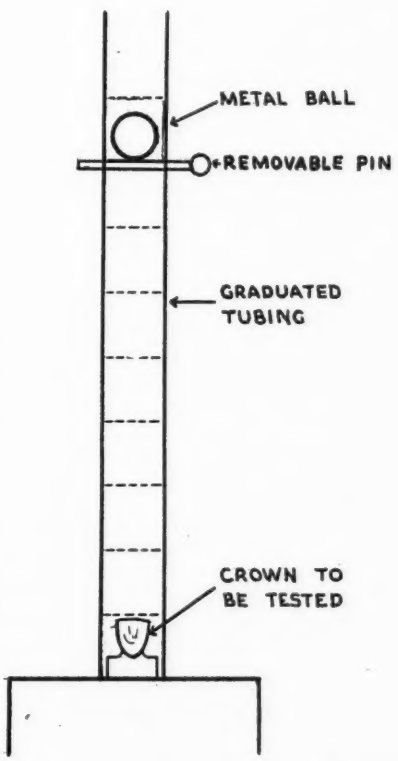

Fig. 2.—Falling ball impact test. The device measures the force needed to *crack* the porcelains.

die well. A stainless steel ball, weighing 18.8 Gm., is dropped from various heights on the specimen. The following scale shows the force, measured in dyne-centimeters, needed to *crack* the porcelains (Table IV).

We took this test a step further and recorded the force which actually *shattered* the porcelain (Table V).

THE NATURE OF THE BOND

The bonding of porcelain to metal is a combination of three separate phenomena. There is a mechanical adhesion brought about by physical entanglement of the liquified porcelain with the rough metal surface during firing. Molecular adhesion occurs, probably because of electrostatic forces. Chemical adhesion is brought about by the reaction between the porcelain constituents and the oxides of the metals (Fig. 3).

TABLE IV. IMPACT STRENGTH FORCE REQUIRED TO CRACK THE PORCELAIN

BONDED MATERIALS	DYNE-CENTIMETERS
Ten per cent iridium and platinum and Apco 1,875° F. porcelain	411,000
Permium 27 and 2,100° F. porcelain	176,000
Permium 22 and 1,800° F. porcelain	117,000
Micro-Bond alloy and regular porcelain	205,000
Micro-Bond alloy and vacuum porcelain	323,000
Improved Ceramco alloy and regular porcelain	164,000

The coefficients of expansion of the metal and porcelain must be close to achieve a good mechanical bond. If an appreciable difference exists between the thermal expansion of the materials fused together, visible checking of the porcelain will occur and a poor bond will result.

All materials tested were examined for coefficient similarity and the expansion curves on all the tested materials were within acceptable limits (Figs. 4 to 7).

STABILITY OF FIT

During the baking cycle, the alloys are exposed to one of the most detrimental physical forces known to metallurgy, extreme heat. At the same time, the porcelain covering is exerting another physical force upon the metal frame. During the firing cycle, all porcelains shrink approximately 15 per cent of their build-up size. In large spans this can be a sizable amount. We know that, clinically, the restorations do seem to fit as well after firing as before. However, certain pitfalls do *appear* to change the fit of the metal frame or *actually* do cause distortion of fit of the metal understructure.

Causes of Change in the Fit of the Cast-Metal Understructures.—The metal is ground to an optimal thickness of about 0.5 mm. at its thinnest portions in preparation to receive the porcelain. If the metal is thinned beyond this, particularly at the

TABLE V. IMPACT STRENGTH FORCE REQUIRED TO SHATTER THE PORCELAIN

BONDED MATERIALS	NUMBER OF DROPS	DYNE-CENTIMETERS
Ten per cent iridium and platinum and Apco 1,875° F. porcelain	5	558,000
Permium 27 and 2,100° F. porcelain	7	528,000
Permium 22 and 1,800° F. porcelain	1	293,000
Micro-Bond alloy and regular porcelain	7	558,000
Micro-Bond alloy and vacuum porcelain	8	559,000
Improved Ceramco alloy and regular porcelain	9	558,000

margins of the castings, the shrinkage of the porcelain may buckle or contract the metal at these thin areas, causing a change in fit.

When the metal span is "porcelainized" and placed into the porcelain furnace for the vitrification of its cosmetic cover, the internal portions of the castings must not be contaminated in any way. Scrapings of low-fusing metals from the master cast may remain inside the copings during the firing process. The components of these alloys (basically tin and lead) incorporate themselves into the alloys of the coping and reduce the fusing range considerably. Two things can happen at this time: (1) the lowered fusing point of the cast-metal understructure in the contaminated part will cause those spots to melt during the vitrification of the porcelain and distort the fit of the metal copings and (2) contaminating factors on the casting will attack the alloy and cause "grain growth." The grain structure of the cast alloy is actually infested by these contaminating substances and becomes enlarged. The orifice of the casting becomes smaller and, hence, a "shrinkage" of the coping occurs.

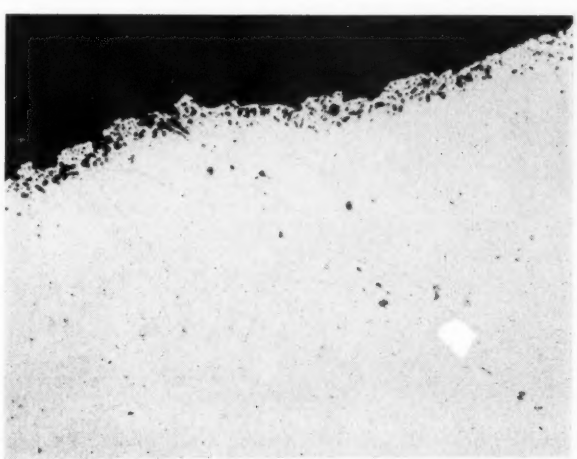

Fig. 3.—A photomicrograph shows the bond between the porcelain and the metal.

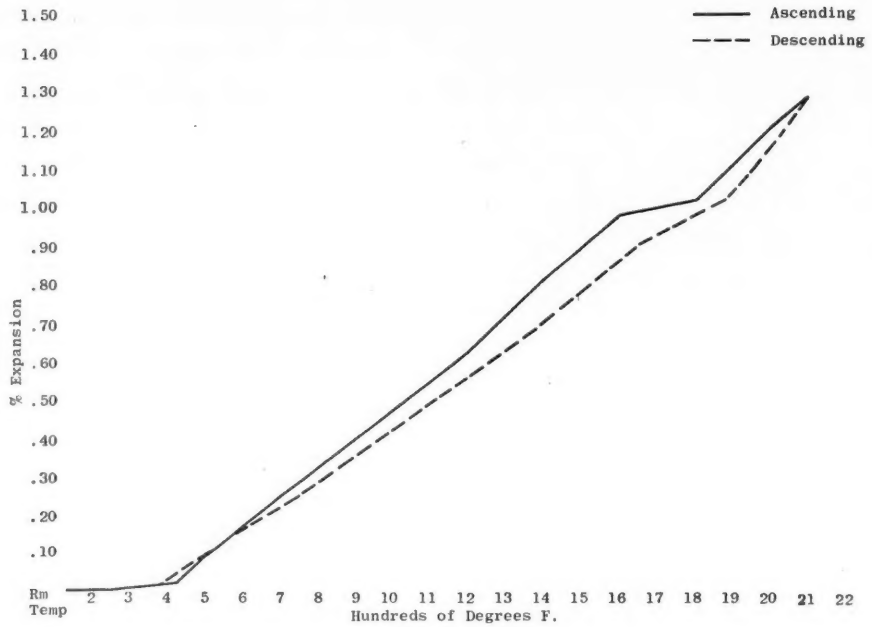

Fig. 4.—The expansion curve of high-fusing Permium 27 alloy. Length of specimen, 1.986 inches. Replotted from New York Testing Laboratories data.

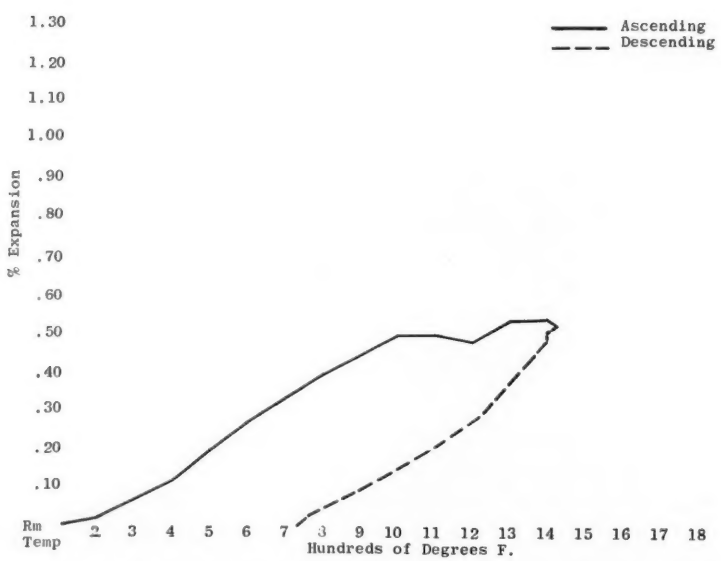

Fig. 5.—The expansion curve of high-fusing Permadent 2,100° F. porcelain. Length before firing, 1.936 inches; length after firing 1.933 inches.

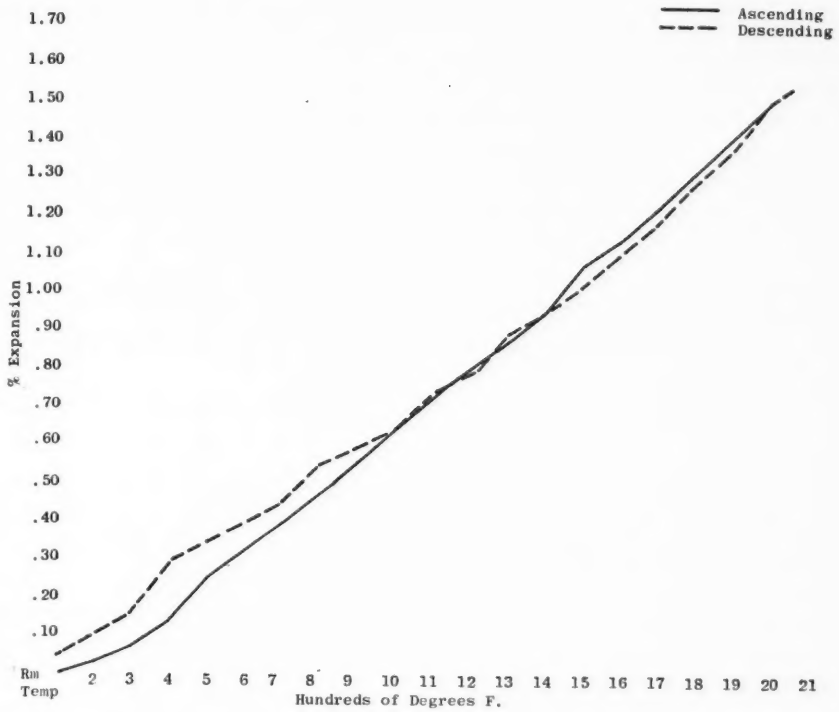

Fig. 6.—The expansion curve of Micro-Bond alloy.

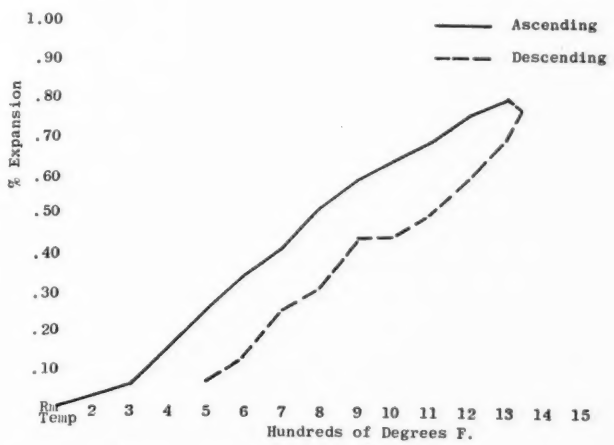

Fig. 7.—The expansion curve of Micro-Bond porcelain (L-2 atmospheric fired).

Causes of Apparent Change in Fit of the Cast-Metal Understructure.—The cast structures of the various metals tested had an average amount of elasticity. During the try-in of the metal in the mouth, the elasticity of the metal plus the mobility of the teeth compensate for undercuts or unparallelism, and the metal will go into place without difficulty. After the metal is porcelainized, the porcelain, being an absolutely rigid material, will not permit any spring or give in the metal. Once the metal is stripped of its quality of elasticity, it will appear not to fit the mouth as it did in its naked state and, in fact, may not fit at all. If the span is forced into position, the porcelain will fracture at the point where the metal must "give" to go into place properly.

During the porcelainization of the metal, tiny grains of porcelain may be deposited inside the copings. When the porcelain is fused, these tiny particles, being transparent, are very difficult to see. When the casting is tried in the mouth, it does not appear to fit.

CONCLUSIONS

Of the materials and techniques tested, the higher fusing porcelains and metals are stronger, more stable, and present the greatest technical latitude. They are preferable, although the equipment, handling, and the time consumed are more extensive.

The office phase of techniques of porcelain fused to metal is critical to the success of the restorations. Preparations and careful examination of the fit of the metal and of the biscuit bake should be performed uncompromisingly. The dental laboratory entrusted to fabricate such a prosthesis should have well trained technicians and be well equipped to complete the laboratory phase of construction without a technical flaw.

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OCCLUSION

AN EVALUATION OF ELECTROMYOGRAPHY IN THE STUDY OF THE ETIOLOGY OF MALOCCLUSION

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MUSCLES SERVE MORE than simply to produce movement. They are also involved in stopping movement and in opposing the action of other muscles so as to produce stability of a body segment.

Movements of the mandible involve both temporomandibular joints and are probably among the most complex movements of all the body segments. It is difficult to imagine mandibular movements occurring without the involvement of muscle components other than those producing the angular displacement.

Grundfest, Oester, and Beebe[1] have summarized the usefulness of the electromyogram in the study of muscle function. They feel that the clinical usefulness of the electromyogram is limited to some extent by what is known about the electrophysiology of muscle. In order to determine the electrical events in an entire muscle (all motor units), the muscle must be mapped with many electrodes and simultaneous recordings made. In addition, the recorded electrical response is complicated by such things as the algebraic summation of electrical activity, the location of the electrodes in relation to the site of activity, the after-potentials, and the geometric arrangement of the muscle fibers. They state, "The relative contributions of one motor unit and another will therefore vary. For these and other reasons the amplitude of the recorded response may have no strict relation to the number of active motor units, and the form of the response may become complicated because of factors which have no relations to the function of the motor units."

In this study we were concerned with total patterns of muscle activity, how they may vary in individuals with different types of malocclusions, and what relation they may bear to the existing deformity. Also, some information on the effect of electrode placement upon the character of the records was obtained. No attempt was made to evaluate the data quantitatively.

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MATERIAL AND METHODS

Electromyographic recordings were made from 38 persons—25 males and 13 females. The ages ranged from 4 to 36 years. Details of age, sex, type of dentition, and type of occlusion are given in Table I. The distribution of the type of occlusion was: (1) normal occlusion, 5 individuals; (2) class I occlusion, 12; (3) class II, division 1 occlusion, 10; (4) class II, division 1, subdivision (unilateral) occlusion, 3; (5) class III occlusion, 3; (6) mutilated occlusion (one or more teeth missing), 5.

TABLE I

SUBJECT	INITIALS	SEX	AGE	DENTITION	TYPE OF MALOCCLUSION
1	R. Z.	M	22	Permanent	Class II, div. 1, sub.
2	E. B.	F	28	Permanent	Mutilated
3	F. L.	M	36	Permanent	Class I
4	J. S.	M	27	Permanent	Mutilated
5	F. C.	M	25	Permanent	Class I
6	F. N.	M	24	Permanent	Mutilated
7	T. F.	M	22	Permanent	Normal
8	L. L.	F	6	Mixed	Class I
9	D. L.	M	4	Deciduous	Class I
10	T. K.	M	10	Mixed	Normal
11	S. S.	F	9	Mixed	Normal
12	R. F.	F	9	Mixed	Class II, div. 1
13	N. S.	M	8	Mixed	Class II, div. 1
14	G. S.	F	9	Mixed	Class III
15	A. H.	F	14	Permanent	Class I
16	I. F.	M	12	Permanent	Class II, div. 1
17	C. L.	F	13	Permanent	Class I
18	E. A.	M	12	Permanent	Class I
19	S. D.	M	13	Permanent	Class II, div. 1
20	L. S.	M	11	Permanent	Class II, div. 1
21	D. T.	F	13	Permanent	Class II, div. 1
22	B. G.	F	12	Permanent	Class I
23	J. R.	F	15	Mixed	Class II, div. 1, sub.
24	D. O.	F	12	Permanent	Class I
25	F. D.	F	8	Mixed	Class I
26	H. K.	M	34	Permanent	Normal
27	O. C.	M	25	Permanent	Mutilated
28	S. M.	M	16	Permanent	Class II, div. 1
29	A. C.	M	13	Permanent	Class II, div. 1, sub.
30	L. M.	M	27	Permanent	Class I
31	J. M.	M	14	Permanent	Class I
32	A. I.	M	34	Permanent	Mutilated
33	B. C.	M	12	Permanent	Class II, div. 1
34	J. M.	F	10	Mixed	Class III
35	J. M.	M	14	Permanent	Class II, div. 1
36	C. A.	M	12	Permanent	Class III
37	A. H.	M	16	Permanent	Class II, div. 1
38	S. K.	M	22	Permanent	Normal

A recording of the resting tonus of the temporal and masseter muscles was made prior to the recordings of the movements of the mandible. Then, lateral excursions, protraction, and retraction of the mandible, respectively, were performed by the subjects.

In executing the lateral movement, the subject was asked to bring the mandible as far as possible to the right or left and then to return to the rest position. In executing the protraction and retraction of the mandible, the subject was instructed to bring the mandible forward as far as possible, then to return to the rest position. In addition, the subject was requested to perform the movements while keeping the teeth lightly in contact. The movements were not performed against any artificial resistance.

Apparatus.—The equipment consisted of an electroencephalograph* coupled to a two channel electromyograph.† Six channels were used for the electromyographic recordings. The electromyograph was equipped with a dual beam oscilloscope, tape recorder, sound system, and inkwriter.

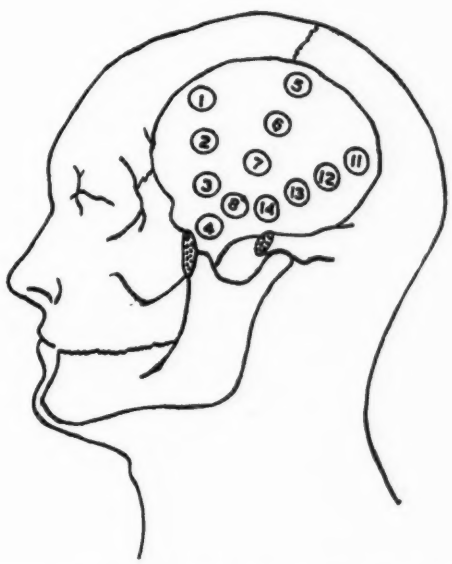

Fig. 1.—The numbered circles indicate the placement of the electrodes on the temporal muscle to test the effect of electrode positioning on the amplitude of the recording.

The settings used on the recording apparatus follow: (1) the gain switch common to all channels was at 12.5 per cent; (2) the low frequency filters of each channel were in the EMG position; (3) the high frequency filters of each channel were at zero; (4) the step gain switch of each channel was at 8; and (5) the fine gain switch of each channel was set so that an input signal of 200 mV. caused a pen deflection of about 8 mm. The two coupled channels were calibrated so as to obtain a similar deflection of the pens at 200 mV.

Electrodes.—Flat, ⅜ inch, silver surface electrodes were used. Bentonite paste was used as the electrolyte. The electrodes were held in place over the temporal

*Medcraft Model D.
†Medcraft Model M2.

TABLE II. LATERAL EXCURSIONS

OCCLUSION	NUMBER OF CASES	SUBJECT	TEMPORAL MUSCLES				MASSETER MUSCLES			
			RIGHT LATERAL		LEFT LATERAL		RIGHT LATERAL		LEFT LATERAL	
			RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT
Normal	2	10, 38	+	+	+	+	+	+	+	+
Normal	1	26	++			+				
Normal	1	11			+	+				
Normal	1	7								
Class I	3	5, 17, 30	+	+	+	+	+	+	+	+
Class I	1	22	+	+	+	++	+	+	+	+
Class I	1	3	+			+	+	+	+	+
Class I	1	31	+			+	+	+	+	+
Class I	1	25	+	+		+	+	+	+	+
Class I	1	18				+	+	+	+	+
Class I	1	15					++	++	++	++
Class I	1	9					+	+	+	+
Class I	1	24					+	+	+	+
Class I	1	8					+			+
Class II, div. 1	3	28, 33, 35	+	+	+	+	+	+	+	+
Class II, div. 1	1	37	++	+	+	+	+	+	+	+
Class II, div. 1	1	13	+	+	+	+				
Class II, div. 1	1	19	+			++	+	+	++	++
Class II, div. 1	1	20	+			+	+	+	+	+
Class II, div. 1	1	21	+			+				
Class II, div. 1	1	16	+	+			+	+	+	+
Class II, div. 1	1	12					+			+
Class II, div. 1, sub.	2	23, 29	+			+	+	+	+	+
Class II, div. 1, sub.	1	1	+	+	+	+				
Class III	2	14, 34	+			+	+	+	+	+
Class III	1	36					+	+	++	++
Mutilated	1	2	+	+	+	+	+	+	+	+
Mutilated	1	4	+	+	+	+	+	+	+	+
Mutilated	1	32	+	+	+	+	+			+
Mutilated	1	27	+	+	+	+				
Mutilated	1	6	+			+	+	+	++	+

muscle with collodion and in the masseter region with adhesive tape. The skin resistance was reduced to 5,000 ohms or less, in most instances below 3,000 ohms.

Both unipolar and bipolar electrode arrangements were initially employed to determine whether they yielded significantly different results. Aside from amplitude, the results were similar, and so most recordings were made with a unipolar setup because of convenience. The reference electrode was placed on the ear lobe.

At least two electrodes were used for the recordings from the temporal muscle, one over the anterior part of the muscle and the other over the posterior part. In many instances, a third electrode was placed over the middle part of the muscle. One electrode was placed at a point midway between the origin and insertion of

the masseter muscle. The muscle potentials were amplified on the loudspeaker system, and the relationship between the sound and the movement was marked on the graphs.

In order to determine the relationship of electrode placement to the nature of the recording obtained, three columns of electrodes were placed—on the anterior, middle, and posterior parts of the temporal muscle. Simultaneous recordings were made from the electrodes in each column while specific jaw movements were performed. The movements were repeated many times while recording with each group of electrodes to minimize subjective differences in performance (Fig. 1).

TABLE III. RETURN TO REST POSITION FROM LATERAL EXCURSIONS

OCCLUSION	NUMBER OF CASES	SUBJECT	TEMPORAL MUSCLES				MASSETER MUSCLES			
			FROM RIGHT LATERAL		FROM LEFT LATERAL		FROM RIGHT LATERAL		FROM LEFT LATERAL	
			RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT
Normal	1	7	+	+	+	+	+	+	+	+
Normal	1	11	+	+	+	+				
Normal	1	26	+	+	+	+				
Normal	2	10, 38								
Class I	3	5, 17, 30								
Class I	1	15	+	+	+	+	+	+	+	+
Class I	1	31	++	+	+	++	++	++	++	++
Class I	1	18		+						
Class I	1	25		+	++					
Class I	1	3		+	+			+	+	
Class I	1	22	+	++	++	+				
Class I	1	8								
Class I	1	9								
Class I	1	24								
Class II, div. 1	3	28, 33, 35								
Class II, div. 1	1	20	++	+	+	++	++	++	++	++
Class II, div. 1	1	21	+	+	+	++	+	+	+	+
Class II, div. 1	1	16	++	++	+	+				
Class II, div. 1	1	37	+	+	++	+				
Class II, div. 1	1	19			+	+			+	+
Class II, div. 1	1	13								
Class II, div. 1	1	12								
Class II, div. 1, sub.	2	23, 29								
Class II, div. 1, sub.	1	1								
Class III	2	14, 34								
Class III	1	36	+	+	+	+	+	+	+	+
Mutilated	1	4								
Mutilated	1	27								
Mutilated	1	6	+	+	+	+			+	
Mutilated	1	2			++	++				
Mutilated	1	32			+					

During all the recording sessions the subject was not permitted to view the tracings. Recordings were made from the temporal and masseter muscles of 29 subjects. Recordings were made from the temporal muscle of 5 (subjects 1, 11, 13, 26, and 27) and from the masseter muscle of 4 (subjects 8, 9, 12, and 24).

LATERAL EXCURSIONS

The activity recorded from the temporal and masseter muscles in lateral excursions and return of the mandible to rest position is summarized in Tables II and

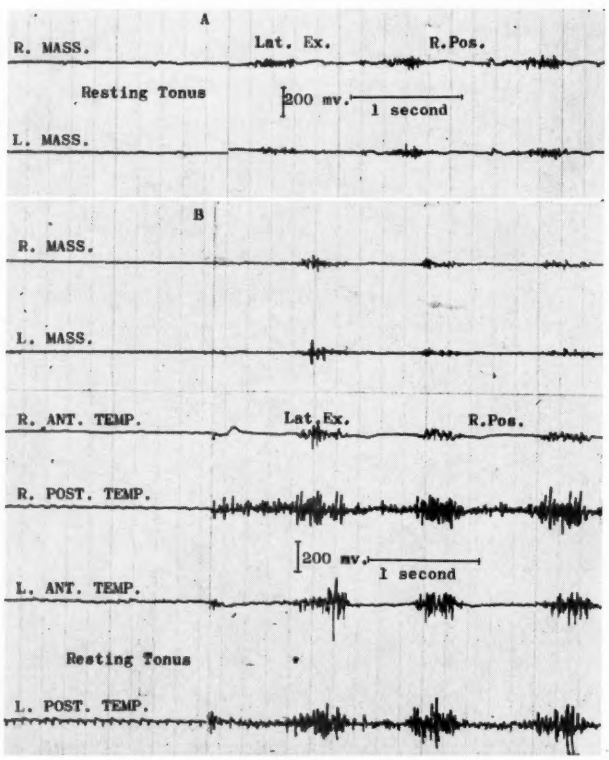

Fig. 2.—*A*, The record from a subject with class I occlusion shows lack of masseter muscle activity during the movement of the mandible to rest position from a lateral excursion: *(R. Pos.)* rest position; *(Lat. Ex.)* lateral excursion. *B*, A Similar result as in *A* is seen from a subject with a mutilated occlusion. Note the activity from the right and left posterior temporal fibers in returning the mandible to rest position.

III. The activity of the temporal and masseter muscles in lateral excursions was quite uniform throughout all groups.

In the majority of class I subjects and in the group with mutilated occlusion, the masseter muscles were not active in returning the mandible to the rest position (Fig. 2). In class II, divsion 1, subdivision, there was no activity of the temporal and masseter muscles in returning the mandible to the rest position.

PROTRACTION AND RETRACTION

The activity of the temporal and masseter muscles in protraction and retraction of the mandible is summarized in Tables IV and V. In approximately one-half of the subjects with normal occlusion there was no activity of the temporal muscles during protraction. A similar result was obtained with the class I subjects (Fig. 3). None of the class II, division 1, subdivision subjects showed activity of the temporal muscles during protraction.

Fifty per cent of the class I subjects showed no activity of the masseter muscles during retraction and very similar results occurred in subjects with the other types of malocclusions (Fig. 4). Several class I and III subjects showed no activity of the temporal muscles during retraction (Fig. 4).

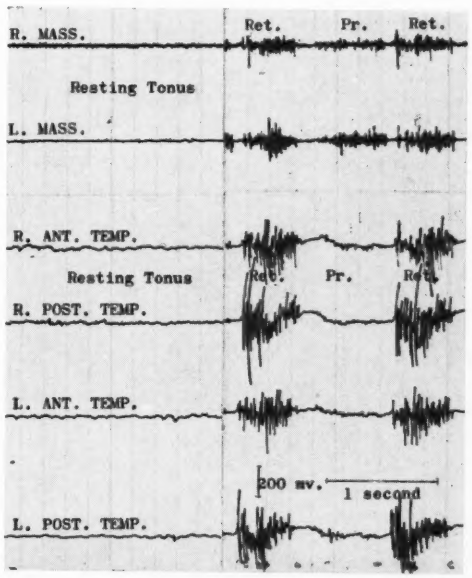

Fig. 3.—A record from a subject with class I occlusion shows lack of activity from the temporal muscle during protraction: *(Pr.)* protraction; *(Ret.)* retraction.

ELECTRODE PLACEMENT

Simultaneous recordings from electrodes on different locations of the three segments of the temporal muscle show that the amplitude of the recording varies with electrode placement. During a lateral excursion, the posterior fibers showed greater activity as a group, and in all three segments the activity appeared greater as the electrode was closer to the fascial origin of the muscle (Fig. 5).

During protraction and retraction, the anterior fibers showed greatest activity as a group. Again, the greatest atcivity was recorded closest to the origin of the muscle (Fig. 6).

During isometric contraction, the greatest activity in the anterior segment shifted from area *1* to area *2* (Fig. 7).

DISCUSSION

Purpose of the Electromyographic Studies.—The rationale for electromyographic studies in patients with malocclusions has been that the malocclusion alters the proprioceptive inflow to the central nervous system from the periodontal structures. This alteration changes the pattern of activity of the masticatory muscles.[2,3]

If electromyographic studies reveal the relationship of sensory input to motor activity, there should be a typical pattern for individuals with normal occlusion. Each type of malocclusion should yield a typical electromyogram or one which has some characteristics related to the deformity. Indeed, some investigators[2-5] have

TABLE IV. PROTRACTION

OCCLUSION	NUMBER OF CASES	SUBJECT	TEMPORAL MUSCLES		MASSETER MUSCLES	
			RIGHT	LEFT	RIGHT	LEFT
Normal	1	26	+	+		
Normal	1	38	++	++	+	+
Normal	1	7			+	+
Normal	1	10			+	+
Normal	1	11				
Class I	2	5, 30	+	+	+	+
Class I	1	17	++	+	+	+
Class I	1	18	+	+	+	+
Class I	1	22	+	+	+	+
Class I	2	15, 25			++	++
Class I	1	3			+	+
Class I	1	31			+	+
Class I	2	9, 24			+	+
Class I	1	8			++	++
Class II, div. 1	1	13				
Class II, div. 1	1	20			+	+
Class II, div. 1	3	16, 35, 37	+	+	+	+
Class II, div. 1	1	19	++	++	+	+
Class II, div. 1	1	21	++	++	+	+
Class II, div. 1	1	28	+	+	+	+
Class II, div. 1	1	33	+	+	+	+
Class II, div. 1	1	12			+	+
Class II, div. 1, sub.	2	23, 29			+	+
Class II, div. 1, sub.	1	1				
Class III	1	34	+	+	+	+
Class III	1	36	+	+	++	++
Class III	1	14			+	+
Mutilated	1	6			++	++
Mutilated	1	2	++	++	+	+
Mutilated	1	4	+	+	+	+
Mutilated	1	32	+	+	+	+
Mutilated	1	27	+	+		

claimed that differences exist between the electromyograms from individuals with the respective types of dentofacial deformities and normal occlusion. Differences in amplitude and duration of the electrical response of the muscle have been the basis for comparison of the electromyograms.

Interpretations Based on Amplitude.—The amplitude of the electromyogram can be affected by several factors such as instrumentation, amplification of individual channels, electrode placement on the muscle, electrical resistance of the skin, anatomic variations in different individuals regardless of type of occlusion (e.g., size and thickness of the muscle), and variations in the performance of the subject which are beyond the control of the investigator. On the basis of our results regarding electrode placement, small changes in the position of the electrode within an area of a muscle can alter the amplitude of the recording to a significant degree and lead to erroneous conclusions.

TABLE V. RETRACTION

OCCLUSION	NUMBER OF CASES	SUBJECT	TEMPORAL MUSCLES		MASSETER MUSCLES	
			RIGHT	LEFT	RIGHT	LEFT
Normal	1	7	+	+	++	++
Normal	1	10	+	+	+	+
Normal	1	38	+	+		
Normal	1	11	+	+		
Normal	1	26	++	++		
Class I	2	15, 25	+	+	+	+
Class I	1	18	+	+	+	+
Class I	1	31	+	+	++	++
Class I	1	3	+	+		
Class I	1	17	+	++		
Class I	1	22			++	++
Class I	1	8			+	+
Class I	2	5, 30				
Class I	2	9, 24				
Class II, div. 1	3	16, 35, 37				
Class II, div. 1	1	12			++	++
Class II, div. 1	1	20	+	+	++	++
Class II, div. 1	1	21	+	+	+	+
Class II, div. 1	1	13	+	+		
Class II, div. 1	1	19	+	+		
Class II, div. 1	1	28	+	+		
Class II, div. 1	1	33	+	+		
Class II, div. 1, sub.	2	23, 29	+	+		
Class II, div. 1, sub.	1	1	+	+		
Class III	1	14	+	+		
Class III	1	36			+	+
Class III	1	34				
Mutilated	1	2	+	+		
Mutilated	1	6	+	+	+	+
Mutilated	1	32	++	++		
Mutilated	1	4	+	+		
Mutilated	1	27				

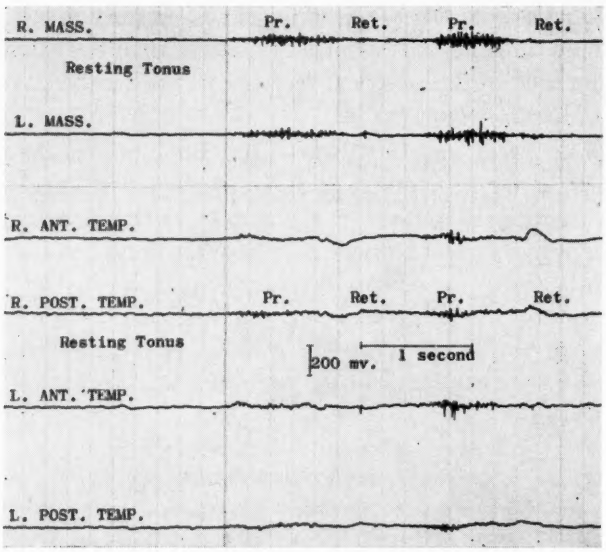

Fig. 4.—A record from a subject with class I occlusion shows lack of activity from both temporal and masseter muscles during retraction.

Taking these factors into consideration, comparisons between data based solely on differences in amplitude are highly questionable. The difficulties in the interpretation of electromyographic data are minimized when dealing with recordings obtained from one subject during one recording session. The greatest difficulties are encountered when attempting to compare recordings made from different subjects.

Patterns of Muscle Activity in Subjects With a Malocclusion.—Our results indicate that there is no definite pattern of muscle activity that can be associated with

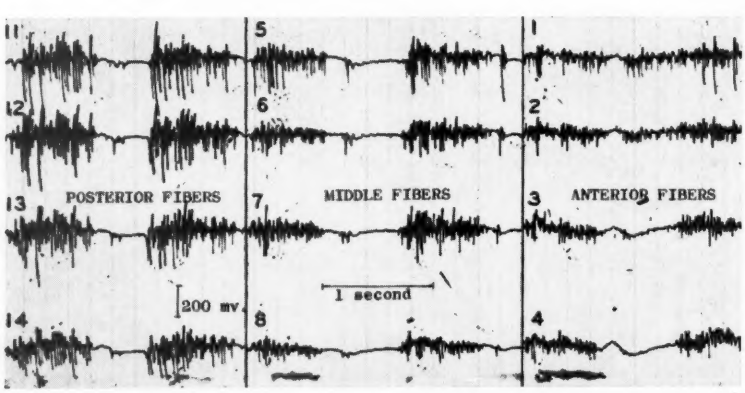

Fig 5.—Records from multiple electrodes placed over the temporal muscle indicate the differences in recorded electrical activity during a lateral excursion. The electrode position and numbers correspond to those seen in Fig. 1.

any particular type of occlusion for mandibular movements in the horizontal plane. On the contrary, the complexity of the mandibular movements and the pattern of muscle activity may vary in different individuals with the same movement. In 9 subjects there was no bilateral symmetry, as regards muscle activity, in the performance of the movements. Furthermore, individuals with similar patterns of activity in lateral movements did not necessarily show similar patterns in protracting and retracting the mandible. These results strongly suggest that the mandibular movements are total patterns of activity involving several muscles rather than simple translations or rotations.

Muscles associated with the temporomandibular joint, as with any other joint, act as functional groups rather than as discrete units. Different individuals may perform similar movements but employ muscle groups that are not exactly the same. Our results show that some persons do not perform analogous jaw movements to the right and left by use of exactly the same ipsilateral muscle groups.

In all of the class II, division 1, subdivision patients, there was no activity of the temporal muscles in return of the mandible to the rest position from lateral excursions. This is not significant for two reasons: (1) the small number of patients in this group and (2) a similar lack of activity exhibited by subjects scattered throughout the other groups.

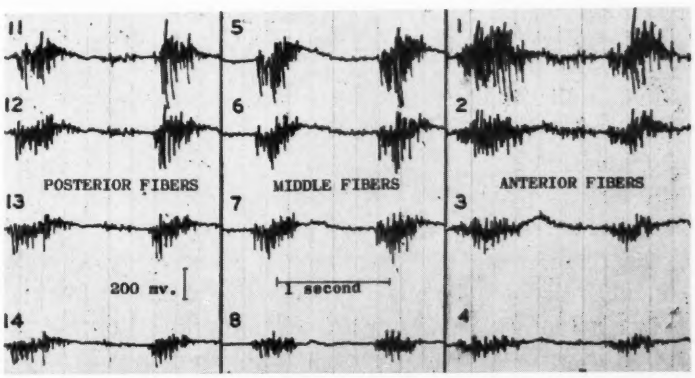

Fig. 6.—Records from multiple electrodes over the temporal muscle indicate differences seen during protraction and retraction.

Patterns in Normal Subjects.—There is such a great variation of the electromyographic patterns from subjects with normal occlusion that it becomes difficult to establish a pattern that can be called normal. As stated above, the results obtained from individuals with malocclusions failed to elicit characteristic patterns for each type of deformity. On the contrary, varied patterns were found to occur and some variations were common to all types of malocclusion as well as to the normal subjects. In addition, the characteristics of the summated action potentials recorded from subjects with a normal occlusion did not differ from those recorded from subjects with a malocclusion.

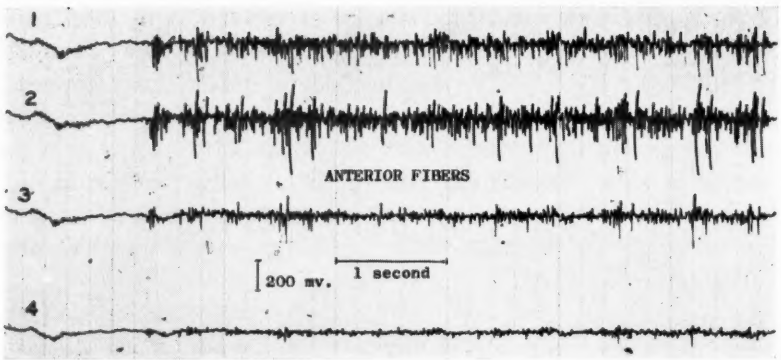

Fig. 7.—The electrical activity is recorded from different areas of the anterior part of the temporal muscle during an isometric contraction.

Significance of Resting Tonus.—The variations in resting tonus ranged from no electrical activity to that suggesting significant activity of one or more muscles. However, there was no correlation between the absence or presence of electrical activity in the resting state and any type of malocclusion. In the light of recent studies,[6] the electrical activity that has in the past been attributed to a resting tonus level or a hypertonicity is probably due to "background noise."

Excessive electrical activity in the rest position has also been called "tremors."[7] Fine tremors are apparently due to anasynchronous discharge from the central nervous system. Coarse tremors are believed to be defects in the process of reciprocal innervation. Both conditions are associated with pathologic neuromuscular conditions. The term "tremors" should be applied only to abnormal muscular activity of the above origin.

Synergistic Action of Muscles.—In discussing the role of the temporal and masseter muscles in lateral excursions and protraction of the mandible, one must keep in mind that these muscles are not the ones primarily responsible for the actual movement. Their action is largely a synergistic one, except for the masseter in protraction. The external pterygoid muscles are the prime movers. However, they do not play a part in retraction. This movement is carried out by the action of the elevators and depressors.

Action of Contralateral Muscles.—Although the result was unexpected, the activity of the contralateral temporal and masseter muscles during lateral excursions may be explained by the fact that these muscles develop tension while lengthening and thereby control the movement and finally terminate it. The action of the ipsilateral temporal and masseter muscles probably plays a part in stabilizing the ipsilateral condyle.

Role of the Masseter and Temporal Muscles in Protraction.—Sicher[8] has described the function of the temporal and masseter muscles in protraction as to prevent the mandible from being depressed by the simultaneous contraction of both the external pterygoid muscles. Regardless of the type of occlusion, all subjects who had recordings from the masseter muscles showed activity of these muscles during protraction. The activity of the temporal muscles was not constant in this movement.

Our results seem to confirm the observation made by MacDougall and Andrew[9] that the masseter muscles actively participate in the movement and that the action of the temporal muscles is synergistic.

In retraction, the activity of the temporal and masseter muscles was fairly constant, with at least one pair of muscles showing activity. However, 7 subjects showed no activity of either muscle above the resting tonus level.

CONCLUSIONS

An electromyographic study of the action of the temporal and masseter muscles in lateral excursions, protraction, and retraction of the mandible was performed on persons with normal occlusion and different types of malocclusion. The conclusions were:

1. The pattern of electrical activity in individuals with malocclusions could be distinguished in no way from that obtained from subjects with normal occlusions.

2. No specific patterns of muscle function were found in individuals with normal occlusion or in those with malocclusions.

3. There is no correlation between the type of occlusion and the degree of electrical activity during the resting state (resting tonus) of the muscles.

4. Electrode placement, among other factors, is apparently of significance in influencing the amplitude of the recording.

5. Other parameters of measurement must be utilized in conjunction with electromyographic techniques to overcome the drawbacks and deficiencies associated with recordings and their interpretation.

We would like to thank Dr. Samuel Hemley, Chairman of the Orthodontic Department, and Dr. Harold K. Addelston, Chairman of the Pedodontic Department, for their cooperation in obtaining clinical material.

REFERENCES

1. Grundfest, H., Oester, Y. T., and Beebe, G. W.: Peripheral Nerve Regeneration, V. A. Medical Monograph, Washington, 1957, U. S. Government Printing Office, ch. IV, pp. 214-219.
2. Jarabak, J. R.: The Adaptability of the Temporal and Masseter Muscles; An Electromyographical Study, Angle Orthodont. **24**:193-213, 1954.
3. Pruzansky, S.: The Application of Electromyography to Dental Research, J.A.D.A. **44**:49-68, 1952.
4. Moyers, R. E.: Temporomandibular Muscle Contraction Patterns in Angle Class II, Division I Malocclusions: An Electro-myographic Analysis, Am. J. Orthodont. **35**:837, 1949.
5. Perry, H. T., Jr.: Functional Electromyography of the Temporal and Masseter Muscles in Class II, Division I Malocclusion and Excellent Occlusion, Angle Orthodont. **25**:49-58, 1955.
6. Nightingale, A.: "Background Noise" in Electromyography, Physics Med. & Biol. **3**:325, 1959.
7. Jarabak, J. R.: An Electromyographic Analysis of Muscular Behavior in Mandibular Movements From Rest Position, J. Pros. Den. **7**:682-710, 1957.
8. Sicher, H.: Oral Anatomy, ed. 2, St. Louis, 1952, The C. V. Mosby Company.
9. MacDougall, J. D. B., and Andrew, B. L.: An Electromyographic Study of the Temporalis and Masseter Muscles, J. Anat. **87**:37-45, 1953.

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TEMPOROMANDIBULAR JOINT DISTURBANCES

TEMPOROMANDIBULAR JOINT PAIN: ETIOLOGY, SYMPTOMATOLOGY, AND DIAGNOSIS

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TEMPOROMANDIBULAR JOINT PAIN is rarely discussed as a clinical entity, although distinct advantages are gained by studying it in a systematic and scientific manner. When a patient has a distinct complaint of temporomandibular pain, an organized approach must be used in the diagnosis.

Temporomandibular joint pain has long plagued man. Ruffer[1] found evidence of pathologic conditions of this joint in early modern man. In 3,000 B.C., the Egyptians knew the anatomy of the joint, and the earliest known surgical text[2] discusses dislocation of the mandible.

Temporomandibular joint pain can be classified[3] on the basis of cause as (1) local pain resulting from a pathologic state of the joint, (2) referred pain from pathologic or pathophysiologic processes elsewhere, (3) pain referred from the temporomandibular joint to other parts, and (4) psychogenic and neurogenic pain of the temporomandibular joint. The etiology, symptomatology, and diagnosis of each classification will be considered.

PAIN OF LOCAL ORIGIN

A pathologic condition of the joint is a frequent cause of temporomandibular joint pain. The pain is produced by the following kinds of disturbances of the joint.[4,5]

Traumatic.—The cause is self-explanatory. A severe malocclusion, such as that with an overerupted third molar, can produce this condition. The symptoms are pain, swelling, muscle spasm, and limitation of motion. The history and a clinical and roentgenographic examination ordinarily suffice for a diagnosis.

Neoplastic.—The symptoms, which include pain, vary and may simulate other conditions. This condition is relatively rare. Roentgenograms will usually suffice to establish the diagnosis.

Infectious.—The symptoms are those of any infection (pain, swelling, and limitation of motion). There may be systemic involvements. The infection is usually

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an extension from an infectious process in neighboring structures and is also relatively rare.

Arthritic.—Either rheumatoid arthritis or degenerative joint disease (osteoarthritis) can cause joint pain and must be considered separately. The etiology of rheumatoid arthritis is still a debatable medical problem. The symptomatology in the early stages is so similar to degenerative joint disease that clinical and roentgenographic examination of the temporomandibular joint cannot differentiate the two conditions. However, the systemic nature of rheumatoid arthritis indicates the diagnosis.

The etiology of degenerative joint disease is not completely understood. A number of factors are involved. Parker and colleagues[6] state that "degenerative arthritis is a process associated with the aging of the tissues of joints, aggravated by strain, hemorrhage, trauma, and static deformities, the end results depending on a summation of these factors." The causes of degenerative temporomandibular joint disease are listed[7] as (1) microtrauma produced by traumatic occlusion, (2) overclosure of the mandible, (3) hypertension of the mandibular musculature, (4) age, and (5) heredity.

The chief symptom of degenerative joint disease is pain on motion which becomes worse on prolonged activity. The pain is usually an aching type, rarely intense. The pain is relieved by rest, but prolonged rest, as in sleep, produces stiffness. Stiffness also is a common symptom. Dry, grating sounds are present in the joint, and swelling and tenderness may also be found. When the pain is severe, the muscles may be thrown into spasm, a protective measure meant to immobilize the joint and so relieve the pain. Roentgenographs are limited in their diagnostic value. However, the films usually reveal arthritic changes in the joint. Clinical examination is the most reliable means of diagnosis.

PAIN REFERRED TO THE TEMPOROMANDIBULAR JOINT

Myofascial pain that originates in the head and neck musculature is often referred to the temporomandibular joint, and it is difficult to say whether local or referred pain is the more common. Referred pain may be produced by (1) muscle spasms, (2) myofascial trigger areas, and (3) muscle spasms in the zone of reference of myofascial trigger areas.

Muscle spasms of the masseter and temporal muscles can refer pain to the temporomandibular joint. The masseter muscle is by far the worst offender in this respect. These muscle spasms can be produced by various causes.[5,8,9,11-13]

CAUSES OF MUSCLE SPASM

Abnormal Strains on the Mandibular Muscles.—Keeping the mouth open too long, in dental treatments for example, can cause the muscles to go into spasm.

Overclosure of the Mandible.—Overshortening the muscles of mastication eventually throws them into spasm from the constant overstimulation of the proprioceptive nerve endings and the reflex arc thus established.

Abnormally Increased Interarch Distance.—Anything which produces an overstretching of the muscles, such as improper dental restorations, will also throw the muscle into spasm as the result of overstimulation.

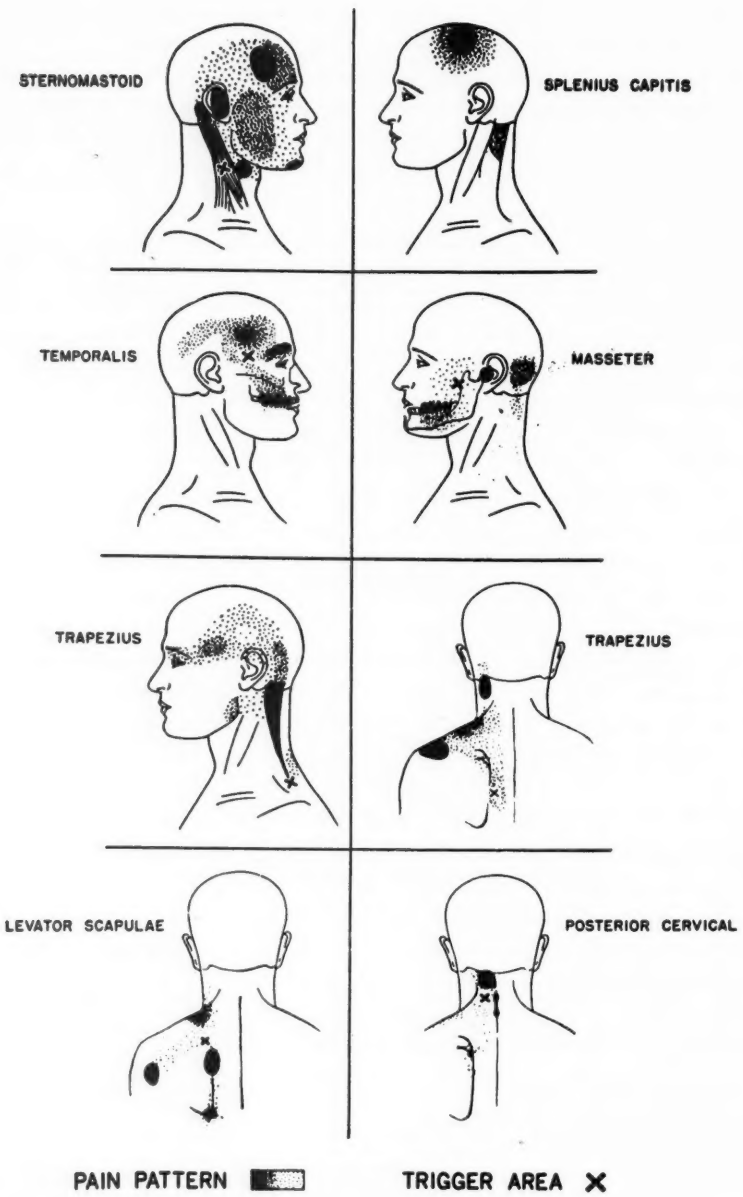

Fig. 1.—The pain reference patterns of myofascial trigger areas are most commonly found in the skeletal muscles of the head and neck. The solid black areas are the "essential" zones in which pain appeared in 100 per cent of the patients. The stippled areas are the "spillover" zones in which pain appeared in less than 100 per cent of the patients. The depth of the stippling indicates the frequency of occurrence. (From Travell, J., and Rinzler, S. H.: Postgrad. Med. 11:425, 1952.)

Malocclusion.—If the attempt of the musculature to establish a harmonious relationship between the jaws during function does not succeed, the muscles will work themselves into a state of spasm in a continuing effort to attain the desired harmony.

Emotions.—Grinding or clenching the teeth produces muscle spasms by the constant stimulation of the muscles and excessive strain.

These muscle spasms are evident on physical examination. The muscles when palpated are clearly in spasm and may even be so contracted as to feel boardlike. Tenderness is usually present. Mandibular dysfunction is also evidenced by a limited ability to open the mouth or a lateral deviation of the mandible on opening, or both.

The myofascial trigger area is a small, circumscribed, extremely hypersensitive region which may appear in any of the myofascial tissues. Impulses arise from the area to bombard the central nervous system and produce referred pain. The trigger area exhibits deep and sharply localized hypersensitivity, fasciculation, and referred pain.

The patient is usually unaware of the existence of the trigger area.

Travell and others[14-20] have shown the presence of these areas in skeletal muscles in many diverse pain syndromes. The areas are specifically involved in head and neck pain and in the symptoms of Costen's syndrome.[21-23] Travell and Rinzler[17] have shown the skeletal muscles of the head and neck from which trigger areas can refer pain to the temporomandibular joint (Fig. 1).

The etiologic background of the myofascial trigger area has been divided by Travell[24] into precipitating and predisposing causes. The precipitating causes are "(1) sudden trauma to musculoskeletal structures, (2) unusual or excessive exercise, (3) chilling of the body, (4) immobilization, (5) an acute visceral lesion, such as myocardial infarction or appendicitis, with localized reflex spasm of the skeletal musculature, (6) acute arterial closure in the extremities, as in popliteal thrombosis, (7) rupture of an intervertebral disk with nerve root pressure, and (8) acute emotional stress."

She lists the predisposing causes as "(1) chronic muscular strain, produced by repetitive movement frequently performed over a long period of time, (2) general fatigue, (3) acute infectious illness, e.g., infectious mononucleosis, acute hepatitis, or an acute upper respiratory infection (postinfectious myalgias), (4) a chronic focus of infection, (5) nutritional deficiencies, (6) a progressive lesion of the nervous system, (7) nervous tension, (8) syndromes of the menopause and male climacteric, and (9) hypometabolism with creatinuria."

Clinically, the myofascial trigger areas can be palpated and, thus, the diagnosis can be established. Zones of reference exhibit hyperalgesia, and the temporomandibular joint may be tender even though there is no local pathologic condition. Thus, locating and eliminating the trigger area is the only means of diagnosis, and the differential diagnosis calls for experience and a fine clinical sense.

A myofascial trigger area can produce muscle spasms in its zone of reference, and one trigger area can produce another trigger area in its zone of reference. Clinical experience and careful physical examinations are necessary for making a differential diagnosis. It is essential to the success of treatment that the trigger areas be completely eliminated. A trigger mechanism may be only partially blocked

when it becomes clinically latent and can be activated at any time by stimuli which are widespread in their occurrence. These activating stimuli are (1) motion which stretches the structure, (2) pressure, (3) needling, (4) extremes of heat and cold, (5) prolonged cooling, and (6) drafts.

When a myofascial trigger area produces muscle spasms in its zone of reference, the pain of the muscle spasms may be referred to the temporomandibular joint. This is a combination of the first two causes of this referred pain. The diagnosis is made by palpating the muscle spasm and then carefully checking for the presence of a myofascial trigger area. The differential diagnosis is simply a combination of those described.

PAIN REFERRED FROM THE TEMPOROMANDIBULAR JOINT

Pain referred from the temporomandibular joint may be due either to a local pathologic state or to a myofascial trigger area in the fibrous tissues of the joint. Bonica[17] points out that when myofascial trigger areas are in muscles, the zone of reference is usually a considerable distance away; whereas, when the trigger areas are in the fibrous tissues of a joint, the zone of reference is usually close by. By far, the most common zone of reference for temporomandibular joint pain is the ear. I have also seen the pain referred to the mastoid region and the tissues posterior to the angle of the mandible, but only rarely.

PSYCHOGENIC AND NEUROGENIC TEMPOROMANDIBULAR JOINT PAIN

Psychogenic temporomandibular joint pain is relatively rare, and its diagnosis is, to a considerable extent, one of elimination. The presence of any pathologic or pathophysiologic process must be carefully checked and eliminated. As is true with all patients, the first visit should include a leisurely and sympathetic conversation to permit an adequate picture of the total human being. Properly conducted, the conversation will indicate how well adjusted the patient is and whether he tends to somatize his emotional problems.

Two diagnostic questions are of considerable help: (1) Does the patient remember the exact time or place when he first felt the pain? (2) What would happen to the patient's life if suddenly the pain could be completely removed?

When there is no organic cause, the patient who names a specific time or place for the onset of the pain should be approached with caution, for this is a strong indication that the pain is of psychogenic origin. A discussion of what was happening to the patient at the time of onset of the pain will often elicit the true cause of the symptoms. This verbalization may even eliminate the pain in some patients.

The second diagnostic question appears to have a very high correlation of accuracy. What would happen to the patient's life if the pain were completely removed. When the pain is psychogenic, the answers show quite clearly that the pain represents far more to the patient than just pain of the described intensity and location. They will say that removal of the pain will produce effects far out of any real relationship to the mere removal of a pain. For example, one patient told me that the elimination of the pain would restore her to a normal social life with her husband and, thus, make her marriage a wonderful thing again. Unfortunately, this

pain was a symptom of hysteria, and the patient violently rejected any suggestion of psychotherapy. Another patient could not open his mouth more than a few millimeters and was an emotionally disturbed person with many problems. His answer to the question was that he would then be able to eat properly again. The clear relationship to the reality of the situation indicated an organic problem, and the final diagnosis was a pterygomandibular hematoma.

Final proof of a diagnosis of psychogenic temporomandibular joint pain can only be provided by the psychiatrist. Extreme care must be observed in clinical treatment because the pain may be the only mechanism for the resolution of the patient's conflicts. In this instance, removal of the pain can produce a disintegration of the personality.[15]

Temporomandibular joint pain of neurogenic origin probably does occur, and if so, it is the rarest of all forms of joint pain. I have never seen it clinically. I have seen pain in the mouth which was the first and, for a period, the only symptom of a cerebral tumor. A neurological examination is necessary for diagnosis.

ROENTGENOGRAPHING THE TEMPOROMANDIBULAR JOINT

Roentgenographing the temporomandibular joint presents a difficult and almost unique problem. Anatomic considerations make this a most difficult structure to visualize by roentgenography. All techniques, of necessity, involve adjusting the roentgenographic apparatus by means of external landmarks. However, the condyle has no constant relationship, either in size, shape, inclination, or position; even the two condyles in the same individual may vary widely. Furthermore, the roentgenogram does not show the articular disk, and the condyle and the articular fossa are seen only in profile in a specific plane.

Five roentgenographic techniques are in use today:

Lateral Roentgenography.—This is the most widely used and the best all-around technique. It shows the position of the condyle in the articular fossa in profile at one particular mediolateral plane and reveals any pathologic condition in this plane. Thus, degenerative joint disease may be present but not be visible if it is in a different plane. Only limited conclusions can be drawn as to the inferosuperior and anteroposterior position of the condyle in the fossa because of the angulation used in making the film. Gross pathologic states such as a fracture or tumor are usually revealed best by this technique.

Anteroposterior Roentgenography.—This technique also shows the articular structures in profile, but it indicates the mediolateral and anterosuperior positions of the condyle in its fossa. Conditions missed in the lateral plates may be revealed, but this film also only shows the structures in profile. It is also useful in showing gross pathologic conditions.

Laminagraphy.—This technique shows a cut of approximately 0.5 to 0.75 cm. in focus and appears to make the articular structures clearer. If the structures could be shown section by section until the full width is revealed, the technique would be superior to the others. However, section by section films would subject the patient to far more radiation than is practicable. What can be seen is limited to a narrow cut and may be distorted.

Arthrography.—This technique is of limited value. By injection of radiopaque material, only the joint cavities and, to some extent, the articular disk may be seen.

Cinefluorography With Image Intensification.—This technique is of great potential value for research purposes. However, it cannot be used routinely for clinical problems.

The use of a long target-film distance markedly improves the quality of temporomandibular joint roentgenograms.[26] The most adequate roentgenographic examination for clinical purposes includes both lateral and anteroposterior films. However, the diagnostic limitations must always be kept in mind.

ROUTINE EXAMINATION

Patients with temporomandibular joint pain should have a definite pattern of examination to reveal the diagnosis. I proceed in the following manner: (1) A sympathetic, unhurried conversation gives a picture of the total human being to be treated. (2) An external examination of the joint reveals tenderness or swelling. (3) The little finger is placed in the external auditory meatus while the patient opens and closes the jaw to reveal the degree of movement of the condyles. (4) A stethoscopic examination of both joints reveals joint sounds. (5) The mandible is checked in opening and closing movements to reveal dysfunction in either degree of opening or lateral deviation. (6) The skeletal muscles of the head and neck are examined for myofascial trigger areas, muscle spasms, or both. (7) Roentgenograms are made of the joints.

SUMMARY

Temporomandibular joint pain has been approached as a clinical entity, and its etiology, symptomatology, and diagnosis have been discussed in detail.

REFERENCES

1. Ruffer, A.: Study of Abnormalities and Pathology of Ancient Egyptian Teeth, Am. J. Phys. Anthropol. **3**:335, 1920.
2. Breasted, J. H.: Edwin Smith Surgical Papyrus, Chicago, 1930, University of Chicago Press.
3. Freese, A. S.: The Differential Diagnosis of Temporomandibular Pain, A.M.A. Arch. Otolaryng. **71**:789-792, 1960.
4. Freese, A. S.: Etiology and Symptomatology of Temporomandibular Joint Disturbances, New York J. Med. **57**:2837-2841, 1957.
5. Freese, A. S.: Mandibular Muscle Spasms and Temporomandibular Joint Disturbances, J. Pros. Den. **8**:831-836, 1958.
6. Hollander, J. L., editor: Comroe's Arthritis, ed. 5, Philadelphia, 1953, Lea & Febiger, p. 692.
7. Freese, A. S.: Degenerative Joint Disease of the Temporomandibular Joint, J. Pros. Den. **7**:663-673, 1957.
8. Sicher, H.: Oral Anatomy, ed. 2, St. Louis, 1952, The C. V. Mosby Company.
9. Sicher, H.: Structural and Functional Basis for Disorders of the Temporomandibular Articulation, J. Oral Surg. **13**:277-278, 1955.
10. Freese, A. S.: Head and Neck Pain in Temporomandibular Joint Disease and Muscle Spasm, A.M.A. Arch. Otolaryng. **67**:410-416, 1958.
11. Freese, A. S.: Mandibular Muscle Spasms: Their Role in Head and Neck Pain and Mandibular Dysfunction, New York J. Med. **58**:2533-2536, 1958.
12. Sarnat, B. G., editor: The Temporomandibular Joint, Springfield, Ill., 1951, Charles C Thomas, Publisher.
13. Schwartz, L. L.: Temporomandibular Joint Syndromes, J. Pros. Den. **7**:489-499, 1957.

14. Travell, J., Rinzler, S. H., and Herman, M.: Pain and Disability of the Shoulder and Arm. Treatment by Intramuscular Infiltration With Procaine Hydrochloride, J.A.M.A. **120**:417, 1942.
15. Travell, J., and Bigelow, N. H.: Role of Somatic Trigger Areas in the Pattern of Hysteria, Psychosom. Med. **9**:353, 1947.
16. Travell, J.: Basis for the Multiple Uses of Local Block of Somatic Trigger Areas (Procaine Infiltration and Ethyl Chloride Spray), Mississippi Valley M. J. **71**:13-21, 1949.
17. Travell, J., and Rinzler, S. H.: The Myofascial Genesis of Pain, Postgrad. Med. **11**:425, 1952.
18. Travell, J., and Weeks, V. D.: Postural Vertigo Due to Trigger Areas in the Sternocleidomastoid Muscle, J. Pediat. **47**:315, 1955.
19. Bonica, J. J.: The Management of Pain, Philadelphia, 1954, Lea & Febiger, pp. 1099-1225.
20. Wolff, H. G.: Headache and Other Head Pain, New York, 1948, Oxford University Press.
21. Freese, A. S.: Myofascial Trigger Mechanisms and Temporomandibular Joint Disturbances in Head and Neck Pain: Differential Diagnosis, New York J. Med. **59**:2554-2558, 1960.
22. Freese, A. S.: Costen's Syndrome: A Re-interpretation, A.M.A. Arch. Otolaryng. **70**:309-314, 1959.
23. Freese, A. S.: The Temporomandibular Joint and Myofascial Trigger Areas in the Dental Diagnosis of Pain, J.A.D.A. **59**:448-453, 1959.
24. Travell, J.: Referred Pain From Skeletal Muscle: The Pectoralis Major Syndrome of Breast Pain and Soreness and the Sternomastoid Syndrome of Headache and Dizziness, New York J. Med. **55**:331, 1955.
25. Freese, A. S.: Temporomandibular Joint Roentgenography: An Improved Technique, J. Pros. Den. **8**:1043-1048, 1958.

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OBSERVATIONS ON ARTHRODIAL TYPES OF TEMPOROMANDIBULAR JOINTS

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VARIOUS OPINIONS ARE HELD by different investigators as to the functional importance of the anatomic structures which take part in limiting retrusion of the mandible. Arstad[1] points out that in other joints, of the digits for example, limitation of motion is due to the joint capsule and re-enforcing ligaments. In the temporomandibular joint, the capsule is slack and flaccid, so much so that it is not injured when the joint is dislocated. The sphenomandibular and stylomandibular ligaments, by their position, cannot prevent the condyles from sliding dorsally. In 1933,[2] Arstad maintained that the anterior part of the joint capsule supports the retruded position. In 1954,[1] however, he described some collateral capsular ligaments as being responsible for limited retrusion of the condyles.

Steinhardt[3] reported in 1934 that the external pterygoid muscle limits retrusion of the condyles. In 1957, however, Steinhardt[4] agreed with Arstad[1] that the collateral capsular ligaments of the temporomandibular joint are responsible. He also said that the muscles are important but did not elaborate. Sicher[5,6] stated that one function of the external pterygoid muscle is to hold the condyle and disc against the posterior slope of the articular eminence while the teeth are in contact. Markowitz and Gerry[7] and other investigators state that the function of the external pterygoid muscles acting together is to cause protrusion of the mandible. The role muscles play in limiting retrusion of the condyles was contradicted by the work of Aprile and Saizar[8] when they obtained symphyseal angle tracings from specimens with the joints intact but with the muscles removed. The work of Posselt[9] also nullified the theory that muscles are the effectors which limit posterior retrusion of the condyles. Posselt obtained Gothic arch (stylus) tracings from anesthetized living persons under the influence of curare.

Ferrein,[10] Breuer,[11] and Rees[12] reported that the retruded position of the condyles is held by the temporomandibular ligament. Kirk[13] was of the opinion that the denture bears the main stress of mastication and prevents the backward thrust of the condyles. Robinson[14] reported that the mandibular condyle in its most retruded position is not normally situated at the bottom of the mandibular fossa but is closer to the posterior part of the tuberculum articulare.

This preliminary report will be part of a thesis in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Anatomy, Marquette University Graduate School.
This investigation was supported by Public Health Fellowship DF-8205.
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Zenker[15] described the retroarticular cushion, which he said was responsible for limited retrusion of the condyles. Zenker called this vascular block the "plastic retroarticular cushion." He said the mechanisms exist behind the convex articular surface which allow a rapid filling and emptying of the space. With forward movement of the condyles the blood vessels fill, emptying when they retract. Alteration of blood vessel walls changes the volume of blood in this vascular block.

In studying the temporomandibular joints of various animals and by comparing the ginglymoid, ginglymal diarthrodial, and arthrodial joints, it was noted that in the arthrodial type of temporomandibular joint, the articular eminence is more flattened and the postglenoid process is less prominent. In the rat, the articular

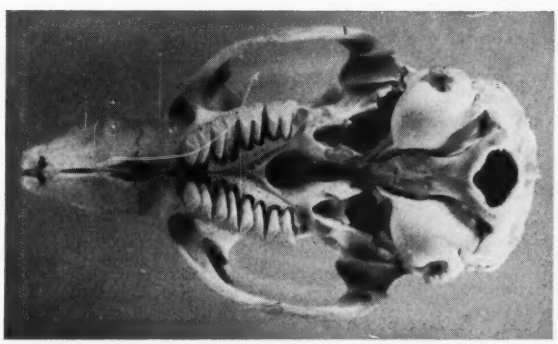

Fig. 1.—A rat skull which shows the absence of an articular eminence and postglenoid process.

eminence is absent, as is the postglenoid process (Fig. 1). Sicher[16] reports that the external pterygoid muscles of cats are relatively weak. These morphologic differences in the various types of temporomandibular joints are consistent with changes in the function of the joint. A morphologic comparison of these structures would lead one to believe that the function of the external pterygoid is concerned with either protrusion of the mandible, lateral excursion of the mandible, limiting retrusive movements of the mandible, balancing the condyles on the articular eminence, or a combination of the preceding functions. It seems logical that the external pterygoid muscles would be stronger in animals with arthrodial types of temporomandibular joints and that they would follow a frontal course if their function were as those listed above.

From the preceding short review, it can be concluded that the major differences in opinion are due to differences in recognition of the significance of the external pterygoid muscle, capsular ligaments, temporomandibular ligament, and retroarticular cushion.

PURPOSE

The purpose of this investigation is to determine what anatomic structures are responsible for limiting retrusion of the condyles in animals with a primarily diarthrodial type of temporomandibular joint. Since this type of joint is analogous

to the upper half of the human temporomandibular joint, it is felt that this investigation will shed some light on the function of the temporomandibular joint of man.

MATERIALS AND METHODS

A special apparatus for obtaining tracings of the mandibular movements of eight rats and one hamster was fabricated (Fig. 2). Tracings were obtained while the animals were anesthetized and, also, when under the influence of curare. Impressions were made of the relationship of the anterior teeth before and after the administration of curare. Care was taken not to displace the teeth while making the impressions. Stone casts were made from the impressions. The tracings and impressions were made with the mandible forced to the most retruded position both before and after the administration of curare.

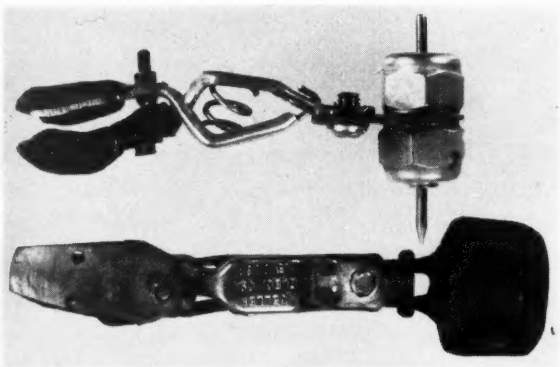

Fig. 2.—The tracing apparatus used on rats, rabbit, and hamster.

On six rats and one rabbit, lateral head roentgenograms were made while the animal was under general anesthesia with the mandible forced to the most retruded position. While the animal was under the influence of curare, the mandible was again forced to the most retruded position and roentgenograms were made.

On three anesthetized rats, all of the muscles of mastication were severed except the external pterygoid muscles. Impressions were made of the relationship of the lower to the upper teeth before and after electrically stimulating the external pterygoid muscles. Stone casts were made from the impressions.

The seventeen rats used were female Sprague-Dawley white laboratory rats. The hamster was a female short-haired English Cavie. The rabbit was a female Sprague-Dawley white laboratory rabbit.

RESULTS

Measurements of the relationship of the upper and lower anterior teeth disclosed that, in every case, the space between the lingual surface of the upper teeth and labial surface of the lower teeth was greater while the animals were under the influence of curare.

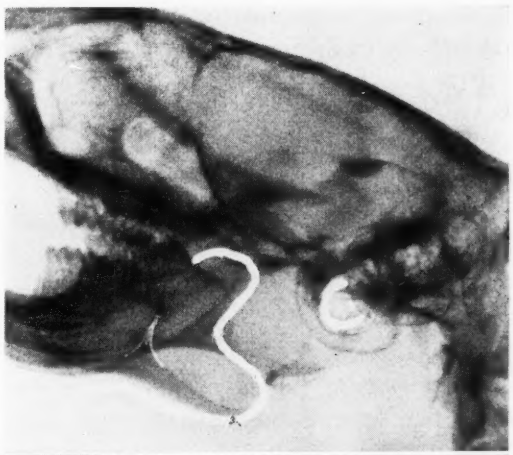

Fig. 3

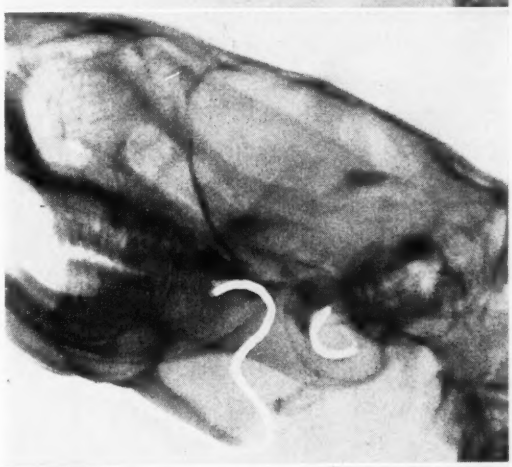

Fig. 4

Fig. 5

Fig. 3.—A roentgenogram of a rat head with the mandible in rest position. Note the outline of the condyle and external auditory meatus.

Fig. 4.—A roentgenogram of an anesthetized rat with the mandible forced to the most retruded position.

Fig. 5.—A roentgenogram of an anesthetized rat under the influence of curare and with the mandible forced to the most retruded position.

Roentgenograms made of the animals while they were under the influence of curare showed that the condyles were retruded 30 per cent more than in those not under the influence of curare (Figs. 3, 4, and 5). The external auditory meatus was used as a reference point in the measurements.

Electrical stimulation of the external pterygoid muscles caused protrusion of the mandible.

DISCUSSION

The results of our tracings of mandibular movements were not conclusive; therefore, they were not used in the analysis of the data. The lower incisors of the rat are easily moved while the animal is under the influence of curare, and it is possible that they may have moved while the impressions were made. Therefore, we cannot assume that these measurements were accurate.

The possibility of error by use of roentgenograms can be considered negligible because they can be superimposed on each other.

In ginglymoid types of temporomandibular joints, the condyles articulate with the processes and prevent further dorsal movements. In ginglymal diarthrodial types of joints, the condyles do not articulate with the postglenoid process, and therefore, they do not limit retrusion of the condyles. Arthrodial types of temporomandibular joints give evidence that limited retrusion is due primarily to muscles and that the external pterygoid muscles are responsible for protrusion of the mandible. The results of our experiments do not exclude the other possible functions for the external pterygoid muscle which were listed in the introduction. Further animal experimentation and study of human subjects are necessary in order to substantiate a similar function for man.

CONCLUSION

In animals with an arthrodial type of temporomandibular joint, the posterior border position of the condyle is determined primarily by muscles, not by ligaments. It is suspected that the external pterygoid muscles are responsible for this position.

Acknowledgment is made to Dr. Walter Zeit, Professor and Chairman of the Department of Anatomy, Marquette University Medical and Dental Schools, and to Mr. Donald Van Scotter, Senior Dental Student, Marquette University, School of Dentistry.

REFERENCES

1. Arstad, T.: The Capsular Ligaments of the Temporomandibular Joint and Retrusion Facets of the Dentition in Relationship to Mandibular Movements, Monograph, Oslo, 1954, A. W. Brøggers Boktrykkeri.
2. Arstad, T.: Central Okklusjon, Norsk tannl. tid. **43**:234-240, 1933.
3. Steinhardt, G.: Untersuchungen über die Beansprunchung der Kiefergelenke und ihre geweblichen Folgen, Deutsche Zahnh. **87**:91, 1934.
4. Steinhardt, G.: Anatomy and Physiology of the Temporomandibular Joint: Effect of Function, Internat. D. J. **9**:155-156, 1958.
5. Sicher, H.: Oral Anatomy, St. Louis, 1949, The C. V. Mosby Company.
6. Sicher, H., and Sarnat, B.: The Temporomandibular Joint, Am. Lect. Series. No. 134, Springfield, 1951, Charles C Thomas, Publisher.

7. Markowitz, H. A., and Gerry, R. G.: Temporomandibular Joint Disease, Oral Surg., Oral Med. & Oral Path. **2**:1309-1337, 1949; **3**:75-117, 1950.
8. Aprile, H., and Saizar, P.: Gothic Arch Tracing and Temporomandibular Anatomy, J.A.D.A. **35**:256, 1947.
9. Posselt, U.: Studies in the Mobility of the Human Mandible, Acta odont. scandinav. **10**:suppl. 10, 19-160, 1952.
10. Ferrein, M.: Sur les mouvements de la machoire inférieure, Hist. Acad. roy. sc., Paris, 1748, pp. 427-448.
11. Breuer, R.: Die Gesetze des einarmigen Hebels angewendet in bau und Funktion des menschlichen Unterkiefers. Festschrift des Vereines osterreichischer Zahnarzte, Vienna, 1911, pp. 67-88.
12. Rees, L. A.: The Structures and Function of the Mandibular Joint, Brit. D. J. **96**:125, 1954.
13. Kirk, E. C.: Study of Dynamics Involved in the Evolution of the Human Dentures in the Relation of Centric Occlusion (Copyrighted), D. Cosmos **76**:631, 1930.
14. Robinson, M.: The Temporomandibular Joint: Theory of Reflex Controlled Nonlever Action of the Mandible, J.A.D.A. **33**:1264, 1946.
15. Zenker, W.: Das retroartikulare plastische Polster des Kiefergelenkes und seine mechanische Bedeutung, Ztschr. Anat. **119**:375, 1956.
16. Sicher, H.: Masticatory Apparatus in the Giant Panda and the Bears, Zoological Series of Field Museum of Natural History **29**:68, 1944.

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COMPRESSIVE STRENGTH OF "REINFORCED" SILICATE CEMENT

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THE PURPOSE OF THIS BRIEF ARTICLE is twofold: to obtain a comparison of the compressive strength of a "new reinforced" filling material which contains impregnated glass fibers with that of two conventional silicate cements and to describe a greatly improved mold for producing test cylinders for measuring compressive strengths.

A.D.A. Specification No. 9 (for silicate cement) calls for test cylinders for determination of compressive strength that are made in molds of stainless steel, glass, hard rubber, or any other substance which will not react with the cement.

This investigation was supported in part by Research Grant D-641 from the N.I.D.R., U. S. Public Health Service, and in part by the Ohio State University Development Fund.

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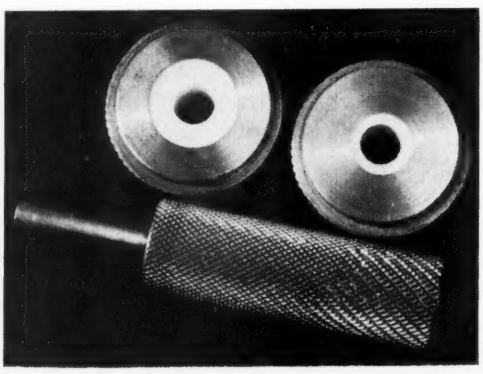

Fig. 1.—Stainless steel molds with Teflon liners (top and bottom views) and brass punch for removing test cylinders. The cylindric cavities are 6 mm. in diameter and 12 mm. in length.

TABLE I. COMPARISONS OF COMPRESSIVE STRENGTHS OF SILICATE CEMENTS

CYLINDER NUMBER	LOAD AT FAILURE (POUNDS)		
	SILICATE A	SILICATE B	"REINFORCED" SILICATE
1	1,275	875	950
2	1,150	925	875
3	1,150	1,050	950
4	1,175	950	1,125
5	975	925	1,050
Average*	1,145	945	990

*All values fall within the acceptable limits (15 per cent). Rounded off, these averages become 1,150, 950, and 1,000 pounds, respectively. A load of 1,000 pounds corresponds to a compressive strength of 22,850 p.s.i., whereas A.D.A. Specification No. 9 calls for a minimum of 23,000 p.s.i.

These molds can be lubricated with a 3 per cent solution of a microcrystalline wax in benzene.

Our experiences with stainless steel molds lubricated in this manner were most discouraging. The action of the liquid portion of the cement was capable of visibly etching the surface of the metal despite the use of the lubricating solution, the consequence of which was inability to remove the hardened cylinders from the molds. We did not attempt to use glass or hard rubber molds but sought a mold of more sturdy construction which would not require a lubricant.

An ideal answer seems to be a stainless steel body containing a Teflon sleeve lining (Fig. 1). The cylinders produced in such molds are easily removed and no lubrication is necessary.

Test cylinders were fabricated in accordance with the manufacturers' instructions for each silicate cement by manual compaction into the molds. The ends of the cylinders were ground smooth with 400 grit carborundum on a glass plate. After 24 hours of immersion in water, the cylinders were dried with a towel and placed immediately on a Dillon testing machine on which the load was applied at a rate of approximately 50 pounds per second. The loads under which failure occurred were read to the nearest 25 pound division on the dial. These loads are recorded in Table I for two conventional silicate cements (A and B) and for one silicate cement containing glass fibers.

CONCLUSION

From these few experimental results it seems improbable that any enhancement of the compressive strength of silicate cements is likely to result from the incorporation of glass fibers.

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CONDENSATION OF DENTAL PORCELAIN

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THE MAJOR PHYSICAL ELEMENTS that are responsible for porcelain particle condensation will be considered as a basis for developing an improved method and technique. There has been no important change in the method of porcelain condensation in a natural atmosphere since the material has been useful to dentistry. Many published accounts on the subject list a group of condensation methods based on the type of instrument selected to manipulate the mix, rather than method being related to the nature of the material. If the porcelain worker has knowledge of pertinent natural physical elements, he can direct them to advantage in improving the condensation method.

PHYSICAL ELEMENTS

Porcelain powder particles of favorable dental composition are mixed with a mobile liquid, usually distilled water, to form a liquid mix of variable viscosity. Working this mix so that the particles are closely packed is known as condensation. The particles are caused to move about over one another under gravitational force by induced instrumental agitation, and the water is brought to the surface where it is blotted away.

The porcelain mix is composed simultaneously of the three states of matter. The powder particles are solid, the water is liquid, and the air inclusion is a gas. Collectively, the mix is in a liquid phase in which the molecules can move about with greater or lesser freedom, depending upon the viscosity of the mass. There is no sharp line of separation between liquids and solids. The molecules of a solid are held rather rigidly together, resist the tendency to change their shape or size, and resist outside forces; liquids do not resist forces tending to change their shape, although they do resist forces tending to change their volume. The molecules of the liquid mix flow freely with respect to each other and spread laterally without restraint under the pull of gravity. Vibration or agitation increases the reaction of any liquid to this fundamental physical law. Vibration is the action common to all prescribed dental condensation methods. These methods require that a liquid of personalized viscosity be used to function as a molding material and that, while piling up this material, a physical force be constantly applied which opposes the vertical volume pile-up of porcelain particles required to meet the specific dental form. To employ a procedure using conflicting physical principles is not good reasoning.

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FORCES USED IN CONDENSATION

Applied forces are responsible for condensation. These forces bring about the motion of the porcelain particles within the mix by pulling, pushing, and tumbling them to close interdigitation of their irregular surfaces, bringing their centers to the shortest possible distance. The natural physical laws which govern the motion of these wetted particles are important.

The most familiar force in Nature is that arising from the pull of the earth on bodies which are on or near its surface. Taking into account the buoyancy of liquids, the resultant upward pressure of a liquid on a wholly or partly immersed body acts at the center of gravity of the displaced liquid, and the weight of the tiny ceramic particle very nearly cancels out the weight of an equal amount of water.

The effective gravitational force for the finely ground porcelain particle is negligible. This is an application of Archimedes' principle that a body immersed in a liquid is buoyed up by a force equal to the weight of the liquid displaced by it. The directional sense of the particles without influence from any outside muscular force is to move downward under the pull of gravity and closer together under the general law of gravitation for all matter.

In a liquid, the molecules move freely with respect to each other but tend to cling together by intermolecular attraction. This is more noticeable in the viscous liquids and least noticeable in the more mobile liquids like water. Not only do the molecules of a liquid cling to each other, but they also cling to the molecules of a solid, as shown when a piece of glass is contacted by water; the molecules of the water cling to the glass and form a thin film over its surface. The small glasslike porcelain particles react in this manner in the mix. The attraction of like molecules for one another is called cohesion, and the attractive force of unlike molecules for one another is adhesion. Both of these natural forces are available because of the nature of the composition of the mix. Intermolecular forces are the same whether they are alike or unlike, and the attraction acts only through small distances. Water, or a similar mobile liquid, then is an essential part of the mix if cohesive forces are to assist the condensation principle. Also, it is seen that the finer the particle grind, the greater the force of interparticle cohesion.

SURFACE TENSION

The surface tension of the ceramic particles in the mix causes the water to wet them. The like molecules of the water have less attraction for each other than for the unlike porcelain particles. The molecular forces responsible for surface tension also cause the molecules of a liquid to rise in tubes which they wet. The molecules of the liquid have force of attraction for each other—cohesion—and also for the molecules on the surface of the wall of the tube—adhesion. The water in the tiny tubes formed between the particles in the mix establishes an ideal physical site for the forces of capillarity, and as condensation progresses and the smaller the interparticle tubes become, the greater becomes the intermolecular force of attraction. Interparticle distribution of water depends largely on the forces of capillary action. The space left between the porcelain particles in the mix forms

imperfect capillary tubes. These tubes extend in all directions, their diameters roughly proportional to the diameter of the particles so that the effective diameter of these tubes is very small (Fig. 1). If the particle size is too large or if the particles are not brought sufficiently close together, fullest advantage cannot be taken of these natural forces when condensing porcelain. Although the mix is used in quite a viscous state, the powder must be thoroughly wetted. The surface tension provides a thin liquid film about each particle in contact with its neighbor. This film supplies an interparticle cushioning effect which influences particle motion and velocity, and since the particle is not elastic and its weight is minimal, collision that is caused by the forces applied brings about a coefficient of restitution that is practically negligible.

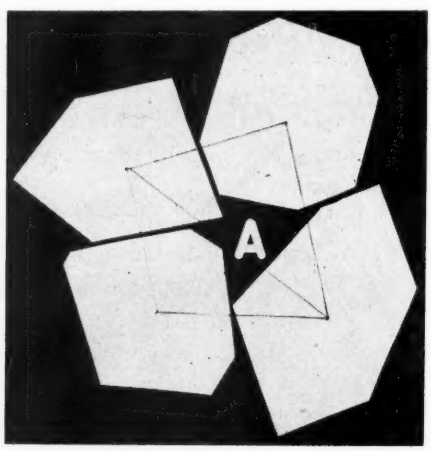

Fig. 1.—An example of porcelain particle arrangement: *(A)* space left between the particles of the mix which forms an imperfect capillary tube.

VACUUM FIRING

Gasses, likewise, play a significant part in the condensation of porcelain. Air, the most important and intimate of gasses, is the one that is concerned when the mix is manipulated. A liter of air at the temperature of melting ice under standard conditions weighs 1.293 Gm. The weight of the column of air through the depth of the earth's atmosphere over the porcelain mix exerts a pressure or force that is considerable. By reducing the atmospheric pressure during the firing of the condensed mix, some improvement in the apparent density and strength of the material has been claimed. A partial vacuum is created in the muffle by pumping out the air, thus reducing the atmospheric pressure within by comparison with normal atmosphere. The forces of this differential draw out some of the trapped air in the mix, and during the pyrochemical reaction when the flux particles reach their mobile liquid state and flow through the unmelted porcelain particles, there appear to be other favorable influences. In any event, the continual maintenance of a negative atmosphere during firing seems to produce a dental porcelain of

greater specific gravity than does firing under normal atmospheric pressure. Too, it seems that the vesicularity of the porcelain is improved. Working the mix in a negative atmosphere in order to assist condensation cannot be considered, for obvious reasons.

Bernoulli's theorem might be mentioned. This theorem states that the greater the velocity of a fluid, the less its pressure. It is conceivable that by controlling the velocity with which water is withdrawn from the porcelain mix, it is caused to rush between the particles with variable velocity. This being the case, the particles move toward the areas where the water is moving with the greatest speed. Care should be taken in the selection of the material used to blot away the excess water that rises in the interparticle tubing. Further, the action of drawing away this water should be continuous during the process of condensation because of its tangible influence.

SHRINKAGE OF PORCELAIN

It has been repeatedly recorded that the paramount cause of shrinkage during the firing of dental porcelain is the lack of condensation.[1,2] Conversely, the usual methods of condensation do not appear to be a considerable factor in the control of firing shrinkage.[2,3] It is probable that the human factor is so dominant in conventional condensation methods that a standard of comparison with which to judge the degree of condensation after any one specific method is impossible. This seems even more likely when one considers any method that makes an attempt to pile up liquids by holding the viscosity of the liquid in a heavy workable state which resists free mobility and at the same time attempts to press the layers of liquid together. The results insofar as condensation is concerned prove to be variable, even in the hands of the expert of long experience.

PRESSURE METHOD TECHNIQUES

Following is a description of techniques which apply a principle bringing into control the natural forces that contribute to particle condensation and which add muscular force to better the degree of condensation of the mix.

There is a special case of a general principle discovered by and known as Pascal's principle. This principle states that the pressure applied to an enclosed liquid is transmitted without diminution in all directions. It is the application of this principle more than any other general factor that can control the application of a packing force on the individual porcelain particles, thereby bringing them earthward into a very close relationship wherein a high degree of condensation can be factually demonstrated.

It is known that liquids cannot resist forces tending to shear one layer of molecules over another and that they have the power to transmit pressure from one part of the liquid to all other parts. Liquids press against surfaces which are vertical or oblique as well as against those which are horizontal. The force is always perpendicular to the surface against which it acts. Comparing forces in different directions at any point in a liquid at rest will show that the pressure is the same in

all directions at all points on the same level and is acted on only by gravity. Clark[1] states, "Surface moisture should be absorbed by touching the work lightly, avoiding pressure. Excessive pressure may disturb the particle arrangement that has already taken place." In contrast, the addition of pressure to porcelain particles that are properly hydrated and rigidly confined during vibration is of primary importance.

If the liquid mix is condensed in a rigid, side-walled mold and if muscular pressure is applied to the mix from above while the mold is being mechanically vibrated at modest amplitude and frequency, this controlled force will push the particles close together. The air inclusion is driven off almost entirely since solids and liquid occupy the available space. The liquid is further caused to rise in the interparticle tubes whose diameters continue to diminish, and the particle closeness increases the effective force of adhesion. This procedure, in principle, was called to the attention of the dental profession in 1950 in relation to porcelain condensation.[4]

PONTIC TIP ADDITIONS

A technique for condensing a porcelain mix addition to be fired to manufactured porcelain teeth for use in bridge pontic construction is suggested. To the usual laboratory armamentarium must be added a rigid facing holder of suitable design. For this a split-mold principle such as that shown in Fig. 2 is good. One frame having three mold forms—one for maxillary central incisors, one for cuspids, and one for molars—may apply universally with the exception of mandibular incisors, for which a form more nearly tooth size is better. The selected facing is clamped within an appropriate mold form, and the opposing tip area recess is lubricated or lined with 0.005 inch tinfoil. The lingual portion of the frame is seated into position and retained by means of a thumb screw. The facing and holder assembly is

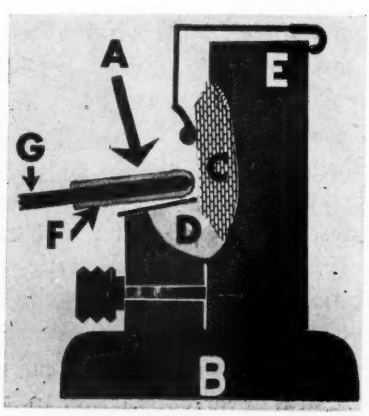

Fig. 2.—A rigid mold design for pontic tip additions: *(A)* the direction of muscular force application; *(B)* the mechanical vibrating table; *(C)* the manufactured facing piece, modified at the incisal edge and at the gingival end, clamped into the mold recess; *(D)* the porcelain mix; *(E)* the face piece of the "pontic" mold; *(F)* blotting material wrapped around a spatula blade; *(G)* a rigid spatula blade.

held on the rubber-covered table of a mechanical vibrator, and the prepared porcelain mix is fed into the tip recess area of the mold. A material having rapid blotting characteristics is wrapped around the working end of a wide rigid spatula, such as is used to mix silicate cement, and is pressed over the open end of the mold. The free water is drawn off. Additions of the porcelain mix will be needed from time to time to compensate for the mass shrinkage as the particles are forced closer together.

Repeatedly adding water freely and immediately drawing it off is recommended. The muscular pressure transmits a force through the handle and blade of the rigid spatula to the particles in the mix, which is contained in a rigid side-walled chamber —the recessed pontic mold. As the spatula, blotter covered or bare, is pushed down-

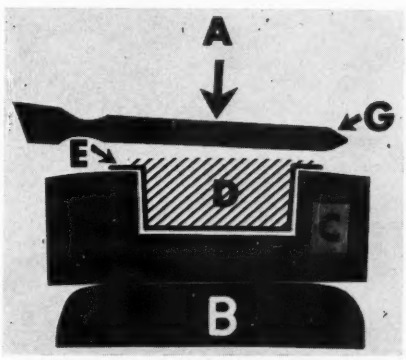

Fig. 3.—The porcelain inlay mold: *(A)* the direction of muscular force application; *(B)* the mechanical vibrating tables; *(C)* the inlay die; *(D)* the porcelain mix; *(E)* the platinum matrix.

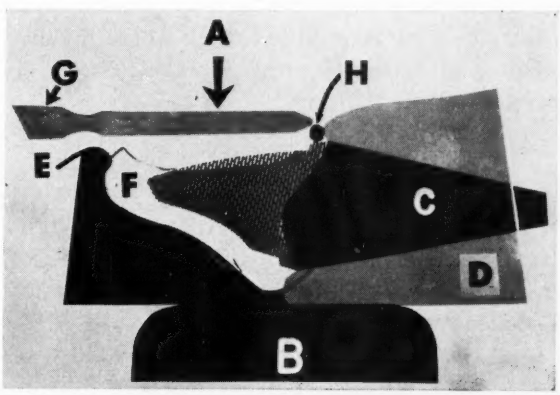

Fig. 4.—The porcelain veneer crown mold: *(A)* the direction of muscular force application; *(B)* the mechanical vibrating table; *(C)* the root form of the crown die; *(D)* the gypsum (dental stone) base of the working cast; *(E)* the tinfoil separating medium; *(F)* the acrylic resin or celluloid crown form modified as described; *(G)* a rigid spatula blade; *(H)* a wax bead sealing the labiogingival and proximogingival areas of the crown form.

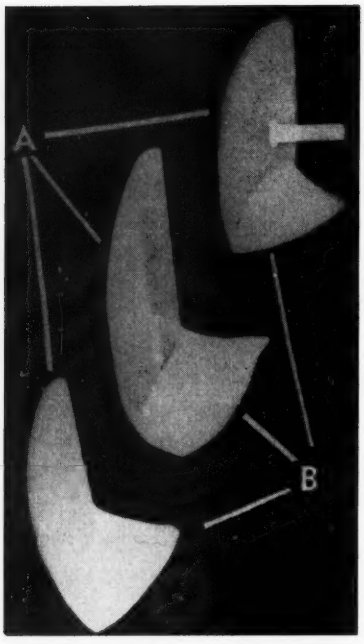

Fig. 5.—A roentgenogram of test samples: *(A)* manufactured facings in 2 mm. sections; *(B)* the porcelain pontic tip additions, adapted to *A*, fired to a high biscuit of the same section thickness.

ward against the mass that slightly overfills the pontic mold, this chamber approaches complete closure and the vertical forces tend to equalize. From time to time, if the downward muscular force is released on the spatula, the freed particles tumble because of the background vibratory motion, and when the downward spatula force is resumed, they reassemble to better condensation. When the condensing is considered complete, the mold is split and the work is recovered. If tinfoil is used to assist the separation, it will stick to the highly condensed particle mass and must be carefully stripped away. The oversize bulk is carved to the desired clinical form preparatory to firing.

PORCELAIN INLAY

The porcelain inlay in dentistry, an intercoronal unit restoration, is usually confined to the class V, one surface variety. The characteristic form of this type of inlay provides a continuous side-walled chamber ideally suited for applying this "closed chamber" condensation method (Fig. 3).

PORCELAIN VENEER CROWN

The physical layout as illustrated in Fig. 4 is used to adapt this closed chamber condensing method to veneer crown construction.[5] An oversize celluloid or acrylic resin crown form serves as a mold from which the labial surface is cut out to

allow intake for the porcelain mix and is festooned at the gingival margin and fitted into the working cast. It is reinforced on the lingual surface of the working cast by a block of modeling compound or cold-curing acrylic resin. Separation is made possible by a layer of tinfoil. The gingival-colored mix is condensed throughout the available areas in the crown form, and the incisal area is cut away. The retained portion is rehydrated, then the incisal color is added and the mass is condensed as one. The two colors bleed into each other for a short distance and no sharp line of demarcation is discernible.

Between 200 and 300 samples were taken from the closed chamber method for comparison with other, more conventional condensation methods over the past 10 years. The samples were vitrified, and their individual degrees of resistance to x-rays proved to be a practical and reliable method of comparison. Ground sections 2 mm. thick were made from a number of different condensing methods and exposed to x-rays on the same film. The samples made by the closed chamber method repeatedly proved to be more resistant to x-ray penetration than those made by any of the other methods, including the manufactured vacuum-fired pieces such as are marketed for artificial dentures and bridge facings (Fig. 5). Macroscopic examination of the closed chamber samples failed to reveal any internal or surface blebs, and the vesicularity of the porcelain was markedly better.

The tendency of porcelain toward the inclusion of voids, pores, or blebs of varying size has long been common knowledge. One of the major laboratory efforts in the manipulation of dental porcelain powder has been directed toward exclusion of these defects.

CONCLUSION

The value of the condensing method described is the projection of a systematized simple procedure which, if followed in principle, seems to produce a mass of dental composition porcelain powder in which the particles are in closer relationship.

REFERENCES

1. Clark, E. B.: Manipulation of Dental Porcelain, J.A.D.A. **22**:33-40, 1935.
2. Skinner, E. W.: The Science of Dental Materials, ed. 4, Philadelphia, 1954, W. B. Saunders Company, pp. 176 and 177.
3. Sayre, L. D.: Effect of Varying Manipulation Upon Certain Physical Properties of a Dental Porcelain, Northwestern Univ. Bull. **38**:3-11, 1938.
4. Baker, C. R.: Porcelain Condensation and Pontics, Fort. Rev. Chicago D. Soc. **19**:5-9, 1950.
5. Klaffenbach, A. O.: Science, Art, and Ceramic Fundamentals Involved in Porcelain Jacket Crown Prosthesis, Austral. J. Den. **38**:88-99, 1951.

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REPORT OF THE COMMITTEE ON SCIENTIFIC INVESTIGATION OF THE AMERICAN ACADEMY OF RESTORATIVE DENTISTRY

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IN PLANNING the Report on Scientific Investigation, it seemed expedient to divide it into several categories. The chairman felt that the report should list the newer developments in dentistry and discuss the probable effects on the course of future dental practice. This then would include the following subjects: (1) biologic investigations, (2) physical investigations, (3) clinical investigations, (4) mechanical investigations, including new equipment and materials, (5) trends in dental education, and (6) sociologic trends that can affect future dental practice.

BIOLOGIC INVESTIGATIONS

Teeth or Hard Structures.—

Caries: Many studies and investigations are being done to explain some of the variations in caries susceptibility that are seen clinically and to get more basic knowledge on the problem.

Some of the variations are in (1) the mineral content of saliva and teeth,[1] (2) the vitamin content of saliva, (3) the endocrine factors in saliva, (4) volume, organic content, and consistency of saliva, (5) the bacteriologic flora of saliva,[2] and (6) the enzymes and antienzymes in saliva.

The 10 year summary of the Sugar Foundation research by Shaw[3] is interesting. It shows that: (1) "Carbohydrates in general, and mono and disaccharides in particular, increase caries incidence." (2) The degree of increase is dependent upon the form of the ingested carbohydrate and the speed of clearing it from the mouth. A chelating agent produced gingival decalcification.

The time of day that sugar is eaten (between meals or at mealtime; before, during, or at end of meal), the form in which sugar is taken (liquid, sticky, or solid), and whether or not it is followed by rinsing and detergent foods are factors leading to variation in caries incidence.[4-7]

Studies on germ-free animals have shown that bacteria are necessary in production of dental caries. Other studies[8-10] show that the presence of bacteriolytic and antibacterial agents can inhibit caries production.

Additional studies of the composition of enamel and dentine from the histologic, biochemical, and physiologic aspects are continuing to add additional information about the cause and variations of susceptibility to caries.

Read before the American Academy of Restorative Dentistry, Chicago, Ill.
*Committee members: Drs. Bruce Smith, Arvin Mann, Ralph Phillips, and Bertram Downs.

Erosion: Erosion has been given very little attention. With the increase in knowledge of the process of chelation and some of the clinical and experimental results regarding it, erosion may be given further study.

Shaw[3] showed that ethylenediaminetetraacetic acid produced decalcification at the cervical ends of teeth. Citrus juices are chelating agents, and chelation is a process which occurs in an alkaline medium. In other words, the dissolution of the structure occurs because of an interchange of metals without an acid medium. Chelating agents act on organic as well as inorganic substances, and this would seem to explain the total loss of tooth structure in erosion.

In periodontics, most studies are clinical in nature, but the biologic approach has been used by some.[11] Fullmer studied connective tissue fibers from the histochemical aspect and found new specialized collagen fibers in connective tissues under great stress, such as in the Achilles tendon and the periodontal membrane. This opens the way for further study of the breakdown of the periodontal membrane in degenerative processes in tissues under stress.

Ramfjord and Kohler[12] have studied the behavior of the periodontium under stress. They found that "remodeling and partial rebuilding of the alveolar process in response to changes in functional occlusal stress took place in all patients regardless of variation of age from 16 to 68 years." A study in time lapse motion picture microphotography has been done by Goldhaber* on the activity of osteoclasts in bone destruction in vivo. This could lead to more knowledge in this field.

The use of bone powders and pastes in the building of new bone has been studied. This work should be followed carefully.

Studies[13] on germ-free animals have shown that periodontal disease and breakdown of supporting structures of the teeth occur without the presence of bacteria.

A list of some of the studies in progress will show a trend in dental research at this time: (1) experimental studies of the decalcification of the hard tooth substances by use of complex compounds (University of Kiel),[1] (2) activity of the masticatory musculature in sleeping persons (University of Kiel),[14] (3) importance of the study of enzymes in the control of oral disease (Loyola University, Chicago),[15] (4) cephalometric study of craniofacial growth in the rhesus monkey (University of Washington), (5) development of the cleft palate in man (University of Washington), (6) prenatal growth and morphology of bony palate in man (University of Washington), (7) anthropometry of Apache Indians (University of Washington), and (8) evaluation of cephalometric landmarks in the study of growth, heredity, and orthodontic treatment effects (University of Washington).

PHYSICAL INVESTIGATIONS

One of the most important physical investigations involves the use of roentgen rays in dentistry. The safe weekly exposure to ionizing radiation, the effects on heredity, and methods of reducing exposure have been established. The allowable dosage has been set at 100 mr. per week, but there are many ways of reducing this. The use of higher kilovolt machines, faster films, aluminum and copper filters,

*Motion picture, American Academy of Periodontology, September, 1959.

diaphragms, and long developing times will minimize patient exposure. The operator exposure will be reduced by these factors and by standing at least 5 feet from the machine. Films should never be held by the operator. Radiation should be checked by a monitoring service. A lead screen can be used for additional protection. The advantages of the long cone technique as an aid in improving the diagnostic quality of the films are becoming recognized. Updegrave has set up a very fine exhibit showing: (1) advantages of long cone over short cone bisection angle technique, (2) improvement in diagnostic quality of film exposure at higher voltages up to 90 kv. over those exposed at 60 to 65 kv., and (3) advantages of use of different types of intraoral and extraoral films to obtain additional views and angles of lesions as an aid in diagnosis.

Experimental work is being done at the University of Bonn, Germany, for two theses: (1) advantages and disadvantages of long and short exposure distances in intraoral roentgenography[16] and (2) use of teleroentgenography with television—tubes and laminography in the study of relationships of oral and skull structures in the diagnosis and treatment of temporomandibular joint orthodontic and prosthetic problems (the technique gives a better image with less exposure).

Some basic research in the use and application of electronics to some dental problems is being done at the School of Aviation Medicine, USAF, Brooks Air Force Base, Texas. One such application is a small radio transmitter placed in the lower denture to indicate lower tooth contacts with the upper denture. There are no wires coming out of the mouth to interfere with normal chewing cycles.

Casting Procedures.—Hollenback and Rhoads[17] are studying wax pattern behavior and its control. The waxes they have studied had insignificant changes on the basis of a clinical evaluation when related to storage time and temperatures encountered in the average dental office.

Stibbs and Korn* (University of Washington) are studying wax pattern distortions with photographic measuring techniques, and a comparison of the two studies should be of interest.

Hollenback and Rhoads[18] have done studies on casting procedures and investments and have found that they get as good or better results by burning out the wax, rather than boiling it out under a partial vacuum as was advocated for some years. Also, very accurate castings have been obtained by the use of straight cristobalite investment.

Cements.—The search for an adequate cementing medium continues. Some studies indicate that the epoxy resins look promising. These resins have no water absorption, since they do not shrink or change after curing. They are stronger than methacrylate resins. With the new catalysts which are nontoxic and have decreased the curing time, they show favorable possibilities for use as cements.

CLINICAL INVESTIGATIONS

Dental care of physically handicapped patients with epilepsy, cerebral palsy, poliomyelitis and other types of paralysis, muscular dystrophy, and mental deficiencies and of patients with an uncontrolled fear is a real problem. Considerable

*Gerald D. Stibbs and James H. Korn: Personal communication.

progress has been made through the use of hypnotic drugs combined with local or general anesthesia and, in some cases, the use of hypnosis. This is a field where dentistry has been reluctant to assume its full responsibility. More effort and study should be expended in this direction so that these unfortunate people can be given the dental care they should have. Much has been written on this subject.[19-21] A new dental hospital has been opened in Southern California, and it is hoped that, with proper indoctrination of dentists to dental hospital routine, these excellent facilities will be used to provide better dental care for patients who require sedation, general anesthesia, and adequate convalescent treatment. The public is ready to accept this type of care, but dentists are slow to provide it.

Drugs.—Attention should be given to some of the new drugs which have been developed to replace codeine, morphine, and meperidine. The benzomorphans are of nonnarcotic origin, are not habit forming, and are more effective with fewer side effects than the other drugs.

Rotational Speeds.—The increasing trend to high speed and oral rehabilitation, plus economic pressures, is influencing dental practice to utilize more auxiliary help and increase efficiency in the operating room. New designs of equipment and arrangement of it on the basis of time and motion studies are having their effect on clinical practice today. We must be aware that all this increased expense and speed of production, if not carefully analyzed and examined, can drift into a degradation of the high standard of professional care for which we are striving. This is not to condemn new techniques or a more efficient way of dental reconstruction, but a warning to guard against some of the pitfalls.

Studies of high speed and full crown preparations and their effect on the pulp have been made by Peyton,[22] Bernier and Knapp,[23] and many others. High speed with small cutting tools and adequate coolants does no permanent damage to the pulp. The dangers are the same or less than with slow speed, large tool pressure techniques.

Pulp Protection.—The number of instances of pulp dying under these high speed conditions, however, seems to have increased. One fact to be considered is that in full crown preparation, many dentinal tubules are cut that have never been exposed before. Therefore, the lumena of the tubules have never been reduced in size as have those where a carious process or erosion or abrasion has stimulated the pulp to recede and block off the irritation to the odontoblasts. If the dentinal fibrilla is a protoplasmic prolongation or remnant of the odontoblast, any cutting of fresh dentine is certain to produce a greater irritation to the odontoblast than the cutting of dentine where caries, erosion, or abrasion has produced a reaction and the formation of secondary dentine and a consequent decrease in the diameter of the tubules. It would necessarily follow that more use of zinc oxide and eugenol sedatives, calcium hydroxide cavity liners, and gum copal liners would minimize pulp death.

Occlusion.—Just before the turn of the century, dentists came to an awareness that the jaw moves in directions other than opening and closing, and the era of articulators began. If the movements of the jaws could be reproduced, teeth could be set so dentures would always exert equal pressure on the residual ridges and no

soreness would result. Each time a failure developed, a new articulator with different controls would appear.

Then the concept was proposed that, if natural teeth exerted equal pressure on each other and none were overstressed, teeth would never develop periodontal disease and there would be no need for dentures. This is a good concept, but certain details have been omitted. The discrepancies in recording mechanisms and articulators are more apparent when the recording mechanisms are attached to solid teeth in dentulous jaws. So, further developments and improvements were made, until today the movements of the jaw can be recorded and reproduced on an instrument. However, not all agree that the recorded movements are those followed in chewing or opening and closing. Also, there are differences of opinion as to what constitutes centric relation and where it is located. There is disagreement as to whether it is at a point or in an area. One consolation in this confusion is that, as the years go by, we are constantly studying and observing these phenomena and are gradually getting closer—slow as it may seem—to the answer.

For many years, most dentists held the same concept of occlusion in natural dentitions and artificial dentures. They believed that the teeth in both situations should contact equally in all ranges of function. There were a few dissenters who were crying in the wilderness, but finally their cries have been heard.

In the last decade, more dentists have seen failures caused by natural teeth with equal balance in all ranges of function. The failures were especially periodontal destruction on the balancing side, as described by Schuyler.[24] D'Amico[25,26] described his concept of cuspid guidance which prevents balance and will reduce cuspal wear so that teeth can maintain centric occlusion in centric relation longer and wear out more slowly.

Smith* has taught a similar concept for fixed partial dentures for some years. It leads to reduction of lateral stresses on posterior abutments.

Stuart[27] found that when teeth are reconstructed with a cusp to fossa relationship and with a cuspid lift, the occlusal surfaces do not wear out. These conditions reduced the lateral stresses on the posterior teeth. Some failures occurred because of excessive lateral stresses which resulted from wide occlusal surfaces and excessive balancing contacts without the "cuspid lift."

This concept must be observed for the next decade or two to firmly establish its clinical validity.

Denture Occlusion.—A new concept for denture occlusion has been developing also. The fact that we have had advocates of cuspless as well as 20 and 30 degree teeth indicates that we have been having some minor difficulties in denture construction, to say the least, and that utopia is not here yet.

The new concept seems to be a step in the right direction. In it, the lingual cusps of the upper teeth fit definitely into the fossae of the lower teeth, and the lingual cusps of the lower teeth are set high so that, on the working side, the upper lingual cusps contact the lower lingual cusps, and the upper and lower buccal cusps do not contact. This puts the vertical stress on the lingual side of the ridges and keeps the dentures stabilized by leverage rather than by atmospheric

*Donald Smith, North Hollywood, Calif.: Personal communication, March, 1959.

pressure. Many techniques have specified very accurate contacts of the buccal cusps on the working side. Balance, in the new concept, is obtained on the balancing side with the lingual cusp of the upper tooth against the buccal cusp of the lower tooth. Dentures may be made in this manner without beading or a "post dam" for retention. In fact, "roofless" dentures have been quite satisfactory when the occlusion was developed in this manner, which would seem to indicate the validity of the concept.

Vertical Dimension.—Vertical dimension is another clinical problem which has not been solved to the satisfaction of everyone. Many techniques, from measurement on pictures and faces divided into thirds to the use of cephalometrics and electromyography, have been used to arrive at a solution.

One technique that seems to have merit has been developed by Skinner.* It involves the use of small plastic cubes of graduated sizes for the patient to chew upon. Patients seem to choose the same size of cubes consistently. This indicates the correct occlusal vertical dimension for each patient. The technique has been tested for more than a year at the Los Angeles County General Hospital Dental Clinic, and the correlation has been extremely promising.

Temporomandibular Joint Disturbances.—Temporomandibular joint disturbances seem to be on the increase. Many problems are involved, and clinical investigators are giving serious consideration to them.

Improved techniques for obtaining roentgenograms of the joint, jaw movement recordings, and a better knowledge of occlusion and vertical dimension are helping in the diagnosis and treatment of these disturbances, but there still is a long way to go.

Schwartz and his group[28] have made a rather concerted effort in this direction, and some investigations are underway on the West Coast. More study of this problem by general dental practitioners is necessary to help prevent situations which lead to temporomandibular joint problems.

Removable Partial Dentures.—Some interesting reports of research and study have come from Europe. A new book by Steiger and Boitel,[29] *Precision Work for Partial Dentures,* describes many basic principles for the use of the various attachments and stress breakers. It also discusses the indications and contraindications for these attachments and describes their technique of construction. It is interesting to note that on the first page of Chapter I of the book are the words, *"Planning is purely and entirely a task of the dentist."* The designs, instruments, attachments, and the method of their use described in this book make us realize that there are others who are working to improve our profession and that we must be alert to maintain our position in dentistry.

Periodontal Disease.—The field of periodontal disease is certainly our concern from the standpoint of diagnosis and prevention through proper restoration (even if we do not provide the treatment). Sheridan and colleagues[30] and Cheraskin[31] point out the dentist's responsibility in the early diagnosis of diabetes. The American Medical Association has reported to the public that a large number of people have diabetes and do not know it. Cheraskin found that of 100 routine

*C. N. Skinner, Whittier, Calif.: Personal communication, May, 1959.

dental patients, 2 were known diabetics but 26 showed definite evidence of decreased carbohydrate tolerance. Three of these came to him with the complaint of "loose teeth," and all 3 had diabetes. Intraoral symptoms were of help in the detection of potential diabetics. Such symptoms as a dry, burning mouth, gingival tenderness, pain to percussion, loss of gingival stippling, spontaneous gingival bleeding, marked color changes, pocket formation, smooth magenta tongue color, tooth mobility and loss, and excessive calculus occurred with greater frequency in patients with decreased glucose tolerance.

Johnson and Wilson[32] reported the use of ultrasonics for the removal of calculus. The results were good and there were no bad effects if the equipment was used properly. The calculus was removed faster and with less trauma to tissue than with other methods.

Operative Dentistry.—Markley's[33] method of placement of multiple pins in broken down teeth and subsequent build-up of an amalgam stump has been the means of saving many teeth that would have been lost otherwise.

Hirsch and Weinreb[34] did some dye penetration studies on amalgam, silicate, and plastic and found that properly condensed amalgam gave a satisfactory seal. Self-curing acrylic resin was a close second, while silicate was a poor third. When self-curing acrylic resin was subjected to a temperature of 140° F., it "leaked" about the same amount as silicate. This phenomenon probably explains part of the clinical failures of some self-curing acrylic resin restorations.

Sterilization.—Studies on sterilization show that some spores and viruses are extremely resistant to ordinary boiling, ultraviolet light, and chemical sterilization. Only superheated steam, hot oil, and hot air are safe and effective.

MECHANICAL INVESTIGATIONS

All of the new types of equipment, such as contour chairs, units, and instruments, will be considered under this heading. Some of the time and motion investigators have thrown the equipment manufacturers into a state of panic with their ideas on the arrangement of chairs, units, cabinets, etc.

I am sure that when down to earth evaluations are made, something practical will evolve from this. However, the dentist who wants to rush in may find he would have been wise to change more slowly. A job may be done a little faster by never moving from one spot, and these time lapse motion picture studies make a dentist look pretty silly jumping around all over the place, but it may be that a little muscle activity of this type will prevent hemostasis and be better for the dentist's health. I am confident that there is a middle road that will lead us on to better dental rehabilitation, produced with less strain on both the patient and dentist.

A new piece of equipment to be watched is the Audiac. Some of the claims for it sound unbelievable, and if true, it will be a great help in carrying out better dental treatment with less patient anxiety and discomfort. However, the mechanism by which it reduces anxiety and discomfort must be evaluated as to its physiologic, psychologic, and histologic effects on the patient. This will be difficult to do until we know how it produces its effects. It is something to look forward to.

TRENDS IN DENTAL EDUCATION

Specialties in Dentistry.—Is specialization in dentistry a desirable development? The Council on Dental Education has been spending a great deal of time re-evaluating the specialty program. Many groups such as endodontics, crown and bridge, dental medicine, implant dentures, and others have been nominated for specialty status to the point that there would be no general dentists, so the Council declared a moratorium to re-evaluate the situation.

Held[35] gives some interesting comments on specialization. At the present time, about 3,600 dentists are recognized specialists in the United States. These are in seven groups: 1,820 orthodontists, 34 oral pathologists, 976 oral surgeons, 270 periodontists, 245 prosthodontists (which includes crown and bridge), 177 pedodontists, and 30 in public health. This growth has occurred since 1946, when the American Dental Association recognized 341 specialists: 235 in orthodontics and 106 in periodontics.

Medicine is completely overrun with specialists to the point that the general practitioner is almost extinct.

In Germany, only three dental specialists are recognized: (1) specialist in tooth, jaw, and mouth diseases (essentially an oral pathologist), who must have both a dental and a medical degree and 3 years in an oral surgery clinic, (2) specialist in oral surgery (two degrees and 3 years in a clinic), and (3) orthodontist (3 years at a university orthodontic clinic). The German Dental Association is against the establishment of further specialties.

In England, four more specialties are planned: oral surgery, periodontics, pedodontics, and prosthodontics. At present, orthodontics is the only recognized specialty in England.

In Denmark, orthodontics is the only recognized specialty.

Intramural Dental Practice.—Another trend in dental education is the development of private intramural dental practices for full time clinical teachers. This is becoming almost essential. Because of the speed with which dentistry is advancing, the clinical teacher should have first hand practical knowledge of the practitioner's problems. Also, the compensation for teachers is so much below that of the practicing dentist that it is a deterrent to those who might take up teaching as a career.

This plan has been carried out at the University of North Carolina, College of Dentistry.[36] At first, there was some feeling by local dentists about unfair advantage to the clinical teachers. However, that has passed, and the plan is working to the benefit of all concerned. It deserves investigation by others as a means of providing better dental teachers who will have a knowledge of the dental practitioner's problems.

SOCIOLOGIC TRENDS

With the social, paternalistic trend in government, new problems which concern the practice of dentistry have arisen. This trend started with (1) the provision of dental care for veterans, (2) the Armed Forces bases in "critical areas," (3) the desire of prepayment insurance plans in medicine to expand to include dentistry, and (4) the union welfare funds (both closed and open panel).

It behooves all of us to take time out from our busy practices and be conversant with the problems and to help find a solution which will not jeopardize the dental health of the public. It is of little personal concern to you whether a satisfactory plan is set up or not, because most of your patients would not be involved. However, you are the men who have shown by your interest and study that the profession of dentistry is *more than a means of livelihood*. It is a *responsibility* for the dental health of the nation, and you have dedicated your lives to giving it the highest rating in the world today. For this reason, you are in a position to fight for the principles and practices which are necessary to produce such service. I plead with you to accept the challenge and let us be open to reason and arbitration, but firm in the ideals of our profession from the health standpoint.

The plan recently put in effect by the Dentists' Supply Company for a prepayment plan should be watched with interest and hope.

Another very distressing situation is the growth of the "denturist movement." It should be called the illegal practice of dentistry. The word "denturist" classifies certain technicians, and its use for a special group should be discouraged to prevent greater recognition. This is a practice that is undermining dental care to the public through false statements and accusations. It is the old pitch of a commodity at a reduced fee. It can be fought by education (of both public and dentist), by action (apprehension and reporting of illegal practitioners), stronger dental laws and enforcement, and cooperation to the fullest between the dental profession and the state dental boards.

I hope you will all make it your business to become better acquainted with these problems and, as leaders in dentistry in your areas, do your share to educate those around you to the necessity for maintaining our profession in its proper stature. Thus, we may protect and preserve the public dental health to the best of our skill and ability.

There are many interesting technical problems that are being solved by research, and the future is bright. The problems in education and sociologic aspects will tax our resources to the limit, but with soundness of mind and determination, we can solve them too.

REFERENCES

1. Haumann, R.: Experimental Studies of the Decalcification of the Hard Tooth Substances by Use of Complex Compounds, Thesis, 1958, University of Kiel, Germany, D. Abs. **4**:61, 1959.
2. Green, G. E., Weisenstein, P. R., and Permar, D.: Studies on Salivary Lactobacilli and Dental Caries in Children During a Dentifrice Test Program, J. D. Res. **36**:828-838, 1957.
3. Shaw, J. H.: Caries-Producing Factors: A Decade of Dental Research—Project No. 3 of the Sugar Research Foundation, Inc., J.A.D.A. **55**:785-789, 1957.
4. Krasse, B., and Gustafsson, B.: Buffer Effect of Saliva Stimulated Between and at Meals, J.A.D.A. **56**:50-54, 1958.
5. MacGregor, A. B.: New Method of Demonstrating the Retention of Foodstuffs in the Mouth, With Special Reference to Different Forms of Sweets, Proc. Roy. Soc. Med., Sect. Odont. **51**:41-44, 1958.
6. Sulser, G. F., Fosket, R. R., and Fosdick, L. S.: Use of a Sodium Dehydroacetate-Sodium Oxalate Dentifrice in the Control of Dental Caries, J.A.D.A. **56**:368-375, 1958.

7. Gish, C. W., Howell, C. L., and Muhler, J. C.: New Approach to the Topical Application of Fluorides in Children, With Results at the End of Two Years, J. Den. Children, **24**:194-196, 1957.
8. Zeldow, B.: Studies on the Antibacterial Action of Human Saliva. I. A Bactericidin for Lactobacilli, J. D. Res. **38**:798-804, 1959.
9. Green, G. E.: A Bacteriolytic Agent in Salivary Globulin of Caries—Immune Human Beings, D. Abs. **4**:49, 1959.
10. Kerr, A. C., and Wedderburn, D. L.: Antibacterial Factors in the Secretions of Human Parotid and Submaxillary Glands, Brit. D. J. **105**:321-322, 1958.
11. Fullmer, H.: Differential Staining of Connective Tissue Fibers in Areas of Stress, Science **127**:1240, 1958.
12. Ramfjord, S., and Kohler, C. A.: Periodontal Reaction to Functional Occlusal Stress, J. Periodont. **30**:95, 1959.
13. Baer, P. N., and Newton, W. L.: Occurrence of Periodontal Disease in Germfree Mice, J. D. Res. **38**:1238, 1959.
14. Emrich, R.: Activity of the Masticatory Musculature in Sleeping Persons, Thesis, 1958, University of Kiel, Germany, D. Abs. **4**:61, 1959.
15. Toto, P. D.: Proteolytic Enzyme-Antibiotic Preparations in the Treatment of Oral Lesions, Oral Surg., Oral. Med., & Oral Path. **12**:696-703, 1959.
16. Querengässer, G.: Advantages and Disadvantages of Short and Long Exposure Distances in Intraoral Roentgenograms, Thesis, 1958, University of Bonn, Germany, D. Abs. **4**:60, 1959.
17. Hollenback, G. M., and Rhoads, J. E.: A Study of the Behavior of Pattern Wax, J. South. California D. A. **27**:298 and 419, 1959.
18. Hollenback, G. M., and Rhoads, J. E.: A Comparison of the Linear Expansion of Investment With the Linear Casting Shrinkage of Gold. IV, J. South. California D. A. **28**:40-46, 1960.
19. Jorgensen, N. B., Levine, M. G., and Hurley, C. T.: Dental Management of Adult Patients With Cerebral Palsy, J.A.D.A. **57**:843-850, 1958.
20. Schiffrin, M. J., Sadove, M. S., and Anderson, A. G.: Narcotic Analgesics as Adjuncts to Dental Practice, J.A.D.A. **57**:71-78, 1958.
21. Monheim, L. M.: Local Anesthesia and Pain Control in Dental Practice, St. Louis, 1957, The C. V. Mosby Company.
22. Peyton, F. A.: Effectiveness of Water Coolants With Rotary Cutting Instruments, J.A.D.A. **56**:664, 1958.
23. Bernier, J. L., and Knapp, M. J.: Methods Used in Evaluation of High-Speed Dental Instruments and Some Results, Oral Surg., Oral Med., & Oral Path. **12**:234, 1959.
24. Schuyler, C. H.: Factors of Occlusion Applicable to Restorative Dentistry, J. Pros. Den. **3**:772-782, 1953.
25. D'Amico, A.: The Canine Teeth—Normal Functional Relation of the Natural Teeth of Man, J. South. California, D. A. **26**:6, 49, 127, 175, 194, and 239, 1958.
26. D'Amico, A.: Application of the Concept of the Functional Relation of the Canine Teeth, J. South. California D. A. **27**:39, 1959.
27. Stuart, C. E.: Why Dental Restorations Should Have Cusps, J. South. California D. A. **27**:198-200, 1959.
28. Schwartz, L., and Coauthors: Disorders of the Temporomandibular Joint, Philadelphia, 1959, W. B. Saunders Company.
29. Steiger, A. A., and Boitel, R. H.: Precision Work for Partial Dentures, Zurich, 1959, Buchdruckerei Berichthaus, and Evanston, Ill., Swiss Dentistry Distributors.
30. Sheridan, R. C., Jr., Cheraskin, E., Flynn, F. H., and Hutto, A. C.: Epidemiology of Diabetes Mellitus. II. A Study of 100 Dental Patients, J. Periodont. **30**:298-323, 1959.
31. Cheraskin, E.: The Problem of Diabetes Mellitus in Dental Practice, J. D. Med. **15**:67-79, 1960.
32. Johnson, W. N., and Wilson, J. R.: Application of the Ultrasonic Dental Unit to Scaling Procedures, J. Periodont. **28**:264-271, 1957.
33. Markley, M. R.: Pin Reinforcement and Retention of Amalgam Foundations and Restorations, J.A.D.A. **56**:675-679, 1958.
34. Hirsch, L., and Weinreb, M. M.: Marginal Fit of Direct Acrylic Restorations, J.A.D.A. **56**:13-21, 1958.
35. Held, A. J.: Is Further Specialization in Dentistry a Desirable Development? D. Abs. **4**:55, 1959.
36. Brauer, J. C.: Private Intramural Dental Practice for Full-Time Clinical Teachers, D. Abs. **4**:52, 1959.

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SURGICAL PROSTHESIS

STRETCHING PROSTHESIS FOR CICATRICIAL DEFORMITIES OF THE LIPS

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PLASTIC SURGERY OF THE LIPS is intended to correct congenital or acquired deformities. Often in keloplasty, prosthetic restorations are used to complement the surgical treatment. This complementary prosthesis acts as a stretching agent against the narrowed rima oris.[1] In this article, two types of prosthetic restorations used in the treatment of cicatricial deformities of lips are described.

STRETCHING PROSTHESIS FOR DEPRESSED LIPS

I constructed a prosthetic restoration based upon the biologic properties of cicatricial stretching by slow and continuous application of stress. The restoration is used to stretch the upper lip which has hardened and has a lowered mobility as a result of keloplastic operation.

The prosthesis consists of a dental splint made over a relieved cast.[2] The splint is thickened in the labial part and is progressively made thicker in two or three steps by the addition of cold-curing acrylic resin at 15 day intervals (Figs. 1 to 5). The increase in the thickness of the labial flange of the splint over a relatively long period of time causes a stretching of the upper lip.

STRETCHING PROSTHESIS FOR THE NARROWED RIMA ORIS

In patients with closure of the rima oris, mainly from burns by caustic soda, I use a prosthetic restoration as a complement to the plastic surgical procedure. This prosthetic restoration is well known and was described by Pont.[3] I simplified the construction and insertion of the restoration by using cold-curing acrylic resin and stainless steel wires (Figs. 6 to 9).

SUMMARY

Two types of prosthesis for complementing maxillofacial surgical operations are described.

Translated from Portuguese by Dr. Dioracy Fonterrada Vieira.
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Fig. 1 Fig. 2

Fig. 1.—The upper lip is depressed and hardened as a result of surgical operation.
Fig. 2.—The side view of the patient in Fig. 1.

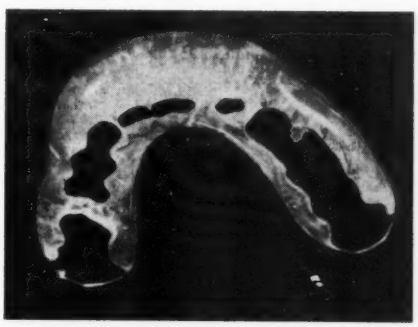

Fig. 3.—An acrylic resin splint is used to stretch the upper lip.

Fig. 4 Fig. 5

Fig. 4.—The splint is in place in the mouth.
Fig. 5.—The side view of the patient in Fig. 4.

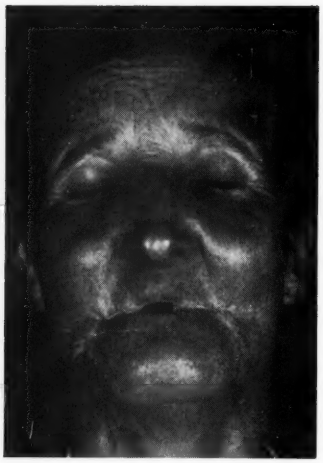

Fig. 6.—A closure of the rima oris resulted from a tissue burn.

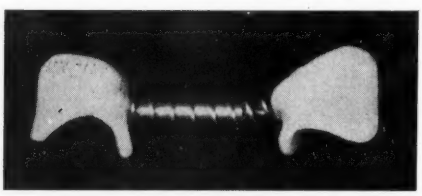

Fig. 7.—The restoration is constructed of cold-curing acrylic resin and stainless steel wire.

Fig. 8

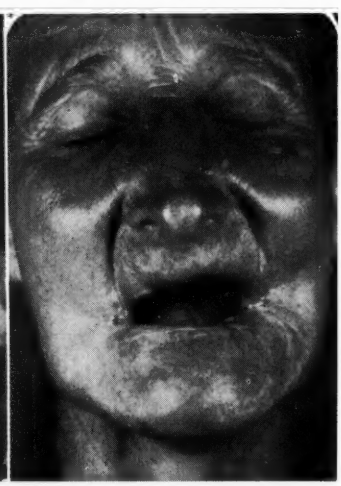

Fig. 9

Fig. 8.—The stretching prosthesis is in place in the mouth.

Fig. 9.—The same patient as in Fig. 6 after she had worn the stretching prosthesis. Note the increased mouth opening.

REFERENCES

1. Fonseca, E. P.: Protese buco-maxilo-facial como complemento da cirurgia plástica, Conference Session—2nd Brazilian Congress on Plastic Surgery, São Paulo, 1958.
2. Fonseca, E. P.: Goteiras dentais—Contribuição para o estudo da adaptabilidade, Thesis, São Paulo, 1957.
3. Friteau, E.: Prothése, Paris, 1925, Gaston Doin, p. 811.

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IMPLANT DENTURES— A PANEL DISCUSSION

TEN YEAR EVALUATION OF IMPLANT DENTISTRY

Introduction to the Panel Discussion

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THE HISTORY OF IMPLANT DENTISTRY is almost as old as the history of dentistry itself. There are reports that the ancient Egyptians attempted the intraosseous implantation of animal teeth and teeth carved from ivory into the mouths of their court women.

In the sixteenth century, Petroneous reported the attempted repair of a cleft palate by the implantation of gold. Maggiolo and Rogers of Paris, in the early nineteenth century, and many others have written about "implantodontics." In 1913, Greenfield reported on the implantation of iridioplatinum "cages" trephined into the alveolar process for carrying crowns and fixed partial dentures. All of these early investigators met with very limited success because they did not have a material for implantation which was compatible with body fluids.

It was not until the modern chrome-cobalt alloys were developed that the problem of electrolytic action in the body fluids was solved. It then became possible to use these chrome-cobalt alloys for the repair and replacement of lost anatomic structures and in the treatment of fractures. This development gave a new impetus to implant dentistry. In November, 1949, Goldberg and Gershkoff[1] published their first report of a modern implant denture.

The four articles which follow constitute a report and an evaluation of only the last 10 years of implant dentistry. The two authors who report favorably for implants are members of the American Academy of Implant Dentures: Col. Roy L. Bodine, Jr., is a prosthodontist and Dr. Allen G. Doner devotes the major portion of his time to oral diagnosis. Two of the authors take the negative side: Dr. Carl O. Boucher is a prosthodontist and Dr. W. Harry Archer is an oral surgeon.

The two articles which express favorable reactions to implantodontics are very enthusiastic in their evaluation of the development of the technique and report suc-

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Introduction to a Panel Discussion at the Centennial Session of the American Dental Association, New York, N. Y.

cesses over a 10 years period. They have case histories and pictures to support their point that implant dentures are possible, practical, and successful.

The two articles written on the negative side of implantodontics raise some very pertinent questions regarding the eventual success of implants. While the authors do not disagree with the favorable reports, they suggest that some further investigation is needed before implants can be recommended for all denture patients.

REFERENCE

1. Goldberg, N. L., and Gershkoff, A.: The Lower Implant Denture, D. Digest **55**:490, 1949.

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IMPLANT DENTURES: SURGICAL—FAVORABLE

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MORE THAN SIX MILLION implants of various inert materials have been made, on all parts of the skeletal framework, as well as in many viceral organs.

In 1948, when Goldberg and Gershkoff[1] proposed the complete mandibular implant with its abutments penetrating the mucosa and subject to oral trauma and contamination, it was thought by most of us to be a failure before it was even started. How could intelligent men, who understood "gingival attachment," even propose such a procedure when it would surely result in infection around the exposed abutments?

If metal implants in a broken arm, for example, are constantly under stress, the adjacent bone is resorbed. What would keep the implant from doing the same thing to the mandibular ridge, particularly when we consider the strength of the muscles of mastication and the diarthrodial ginglymus nature of the temporomandibular joints with their varied movements?

In 1952, when I went to Providence, Rhode Island, to work with Drs. Gershkoff and Goldberg, I went there as a skeptic. How could the reports of successes be true on a procedure that seemingly defied the results we would expect according to our concepts of physiology, anatomy, histology, pathology, and mechanics? I became less skeptical after participating in the insertion of six implants and observing and talking to 15 or 20 patients. They had successfully tolerated implants for periods of time ranging from recent to several years.

"The proof of the pudding is in the eating"—complete mandibular implants *can be* and *are* successful. Dr. Isaiah Lew presented a paper entitled "A Ten Year Evaluation of Implant Dentures" at the Chicago Dental Society Mid-Winter Meeting in February, 1959, in which statistical evidence of the gratifying successes of implant dentures was presented.

GINGIVAL ATTACHMENT

Today we realize that the textbook interpretation of the "gingival attachment" may not have been accurate. We were taught that the epithelium which formed the enamel remained attached to the enamel and later with the eruption of the tooth became contiguous with the stratified squamous epithelium of the oral mucosa. Reattachment was deemed impossible. Why, then, do we get a normal gingival condition around a second molar after retracting the mucosa from the tooth and

Presented before the Section on Implant Dentistry at the Centennial Session of the American Dental Association, New York, N. Y.

*Assistant Professor of Diagnosis.

bone while making a buccal flap for the removal of an impacted third molar? Following a buccal flap operation, after a suitable healing period, a periodontal membrane explorer cannot be passed any deeper than normal between the tooth and the gingivae, neither can it be passed between the gingivae and the implant post. I have been unable to get a positive result with a subgingival irrigation test* around a healthy implant post. Histologic sections of healthy oral mucosa taken from around a post exhibit a downgrowth of stratified squamous epithelium comparable to that of a normal gingival crest. If the mechanical cuff or collar of mucosa around the posts were not tight, the histologic sections would surely show definite evidence of inflammation.

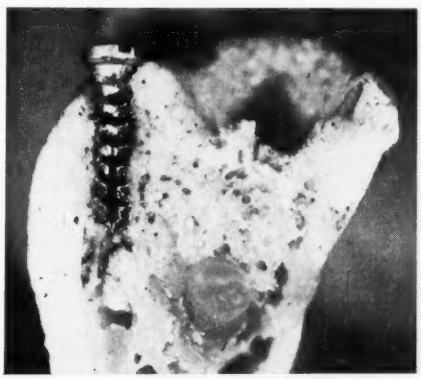


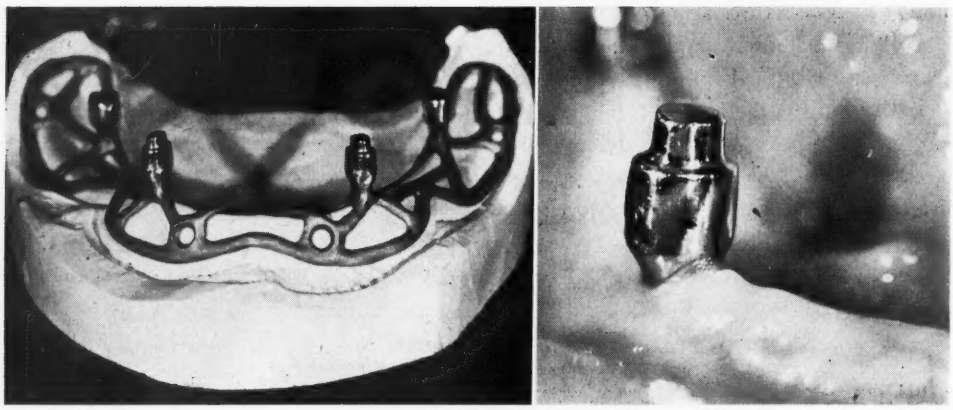
Fig. 1.—A cross section through a mandible in the region of the retromolar pad. The buccal and lingual plates are dense cortical bone, while the ridge area is cancellous bone.

FOREIGN BODY REACTION

If the old concepts of bone resorption under and around a foreign body are true, why do we see implants that have been successful for more than 10 years on resorbed mandibular ridges that are only one-half or one-third normal size? The employment of the implant substructure with its widespread stress-bearing areas on the dense cortical bone can be compared with the Eskimo's use of snowshoes to help distribute the load over a far greater area. The bone picture speaks for itself (see Figs. 1, 2, and 5).

In fracture work, if Roger-Anderson or Haines-Griffith pins or screws are employed, we expect bone resorption around the metal because these pins or screws are under stress. If a metal plate is used in long bone fractures (arms or legs), there is no evidence of bone resorption after union because the metal is not under stress. Likewise, in implant procedures, if the substructure is flat and under ex-

*A subgingival irrigation test is a diagnostic aid employed to detect infection or inflammation in creviced areas. A 25 or 26 gauge, 1¼ inch hypodermic needle is blunted by removing the point and rounding the edges, and the needle is bent to a 45 degree angle. (A gold-plated needle of this design is commercially available but is usually a heavy gauge.) A Luer syringe is filled with 3 per cent peroxide and employed by placing the needle into the crevice and firmly but gently irrigating. The amount of foaming (caused by the oxygen release) is in direct proportion to the amount of inflammation, infection, pus, or degenerated debris present. This test is frequently employed to determine infection around partially erupted lower third molars.



A. *B.*

Fig. 2.—A lower implant substructure. *A*, On the cast. Note that the stress-bearing parts are on dense cortical bone and are extended sufficiently to prevent lateral movement and torque. *B*, A post of the substructure 3½ years after insertion. The tissues are healthy, the "gingival collar" is tight, the implant is firm, and the patient is comfortable with dentures that function well.

tended torque, stresses inevitably develop and resorption results. Inversely, if the substructure is properly designed and adequately extended to prohibit any movement or torque stresses, resorption around the implant does not occur.

INDICATIONS FOR IMPLANT DENTURES

Implant dentures are intended neither as a panacea or cure-all for all edentulous patients nor as a replacement for good soft tissue–borne dentures. Ninety-nine per cent or more of all edentulous patients can tolerate conventional dentures and should use them. The remaining 1 per cent or less comprises the unfortunate individuals who cannot have adequate dental function without additional help. *These* and *only these* are the patients for whom implant dentures should be constructed. I have limited my interest to complete mandibular implants on very difficult cases. This should not deter those dentists who wish to make maxillary or partial implants. My attitude may be overly conservative, but I completed two mandibular implants and then refused to insert another implant until I had an opportunity to observe my own work for at least 6 years.

SUCCESS OR FAILURE

Success and failure are relative terms. If a porcelain or silicate filling lasts for only 6 years, it is a success; if a gold inlay or fixed partial denture lasts for only 6 years, it is probably a failure. If a removable partial denture is constructed for a difficult case under unfavorable circumstances and serves the patient well for only 5 to 10 years, it is not frowned upon as a failure. What, then, do we expect of implant dentures when we are working with debilitated patients who have atrophied or resorbed mandibular ridges, poor muscle attachments, etc.?

I feel that if an implant, whether it is in the mouth or in the hip, serves the patient well for more than 6 years, it can be considered successful. I am not im-

plying that 6 years is the life expectancy, because many men, e.g., Gershkoff, Goldberg, Lew, Jermyn, Bodine, and many others, have great numbers of patients who have worn implants successfully for from 6 to 10 years.

OPPOSITION TO IMPLANTS

I believe the greatest opposition to implant dentures comes from the oral surgeons. This is understandable. The only implant dentures the oral surgeons see are those referred for removal. Why? First, there is no reason or occasion to refer a successful case. Second, because the person who inserted the original implant felt himself incapable of handling the case when it was in trouble. In all probability, he was not well enough qualified to make the original insertion and should never have attempted to make the implant in the first place. This is the reason there should be a specialty board in implant dentures—to limit the activities in implant procedures to qualified dentists.

I have occasionally encountered teams consisting of an oral surgeon and a prosthodontist working together. This is *good, if* both men are entirely familiar with implant procedures. But the blind should not lead the blind. Would you employ an automobile mechanic and a pilot to service your airplane, or would you hire an aircraft mechanic who is familiar with the factors peculiar to aircraft, of which neither the pilot nor the car mechanic (no matter how competent they are) is aware? So it is with implant dentures. Everyone concerned must be completely familiar with the "nature of the beast" and this means more than reading a book or journal and seeing an implant inserted. It means a thorough knowledge of *details* from the *diagnosis* to periodic recalls. At no time after starting an implant can lack of care be allowed.

The history of most of our implant patients discloses that their teeth were lost for periodontal reasons. How often in implant procedures or in conventional denture construction, or in periodontal work for that matter, are systemic fatcors, i.e., metabolic dysfunction, dietary deficiencies, endocrine dysfunctions, systemic diseases, etc., taken into consideration? They are of vital importance and must be carefully evaluated.[2]

I have seen unfortunate patients with poor ridges wearing good, well-fitted, well-balanced, properly occluded conventional dentures which were constructed by competent prosthodontists; yet, these patients were unable to bite into a soft piece of bread. However, when they had implant dentures constructed, they took a new lease on life and were able to snap a lead pencil in half with the new dentures as a "stunt" to demonstrate their efficiency. These grateful patients are the compensating factors in implantodontics.

The finest details of good prosthetic procedures (face-bow mounting, centric relation, vertical relation, condyle path inclination, balanced occlusion in all ranges, etc.) are absolutely essential in implant denture procedures because there is no "give" (tissue compensation) for minute errors. Since my portion of the program deals primarily with the surgical phase of implant denture service, I am omitting a discussion of these prosthetic procedures in order to concentrate on the characteristics, requirements, and considerations peculiar to implants.

The following illustrations and reports will demonstrate many of the considerations essential for implant denture success. Fig. 1 shows a cross section of the mandible in the pad area with a screw in place in the cortical bone. The cortical bone on the lingual and buccal aspects is thick and the ridge area is cancellous. With

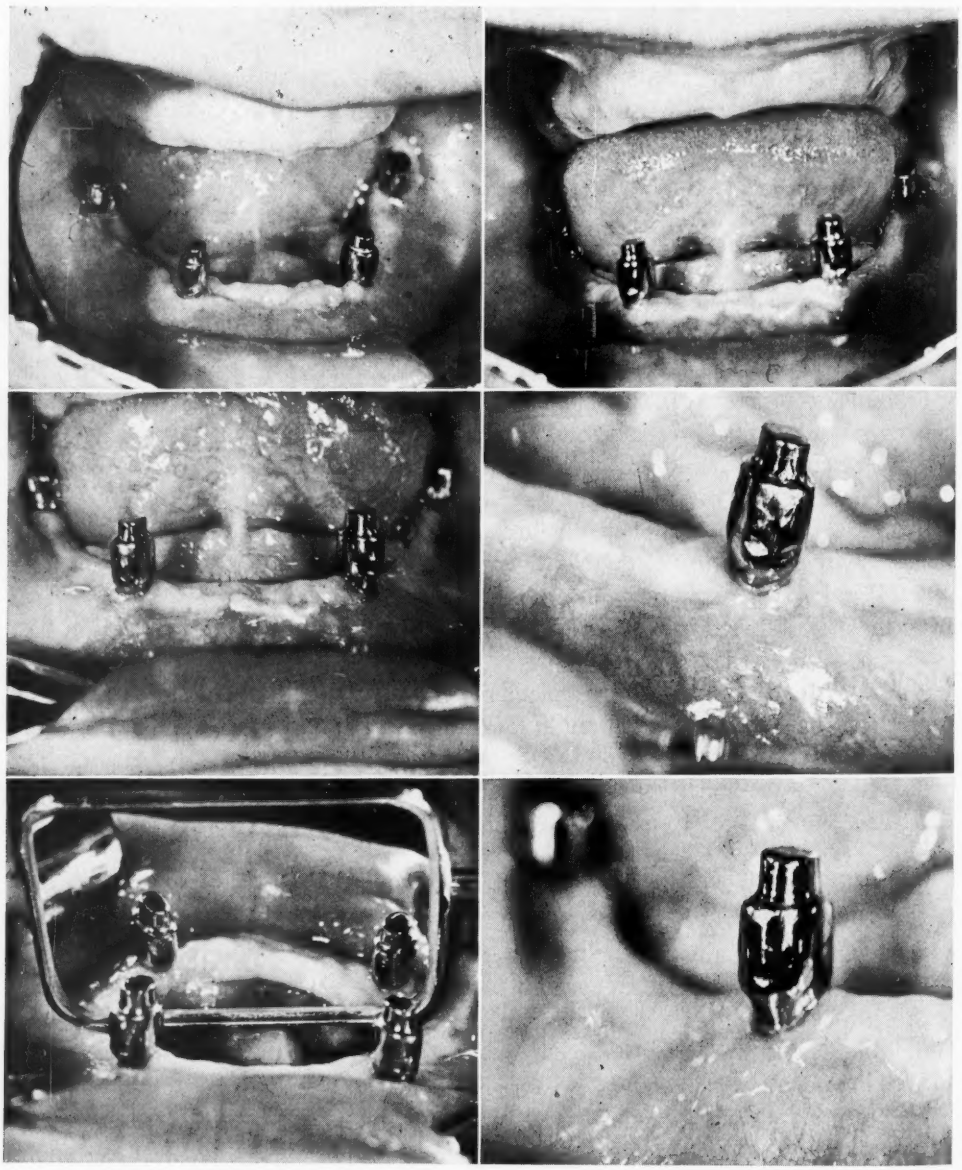


Fig. 3.—*A*, The implant substructure has been in position 1 month. Note the poor ridge and the implant posts. *B*, The implant 14 months after insertion. *C*, Three and one-half years after insertion. *D*, Five and one-half years after insertion. *E*, Lingual view of the anterior posts after 5½ years. *F*, Seven and one-half years after insertion. Note the healthy mucosa throughout. The "gingival collars" are tight around the posts. There is no recession around the abutments and no implanted metal is exposed. The patient is comfortable and has excellent denture function.

conventional dentures, the load is almost entirely confined to the soft ridge area because the soft tissue attachments place the dense cortical bone out of reach. In implant procedures, it is this dense cortical bone that supports the denture and not the soft, easily resorbed bone of the residual alveolar ridge.

We keep the cross struts of the implant substructure thinner and finer than shown in Fig. 2 and endeavor to avoid all unnecessary struts over the center of the ridge surface where the bone is more cancellous. The load-bearing area is placed entirely on dense cortical bone.

Three and one-half years after this implant was inserted, the appearance of the mucosa was healthy. I could not pass the periodontal membrane explorer any deeper than the usual 1.5 mm. expected of a normal gingival sulcus. Subgingival irrigation test results were negative, and the patient was symptom-free.

Fig. 3 shows the history of another implant. This patient had worn several conventional dentures unsuccessfully, but since the implant had been inserted, she

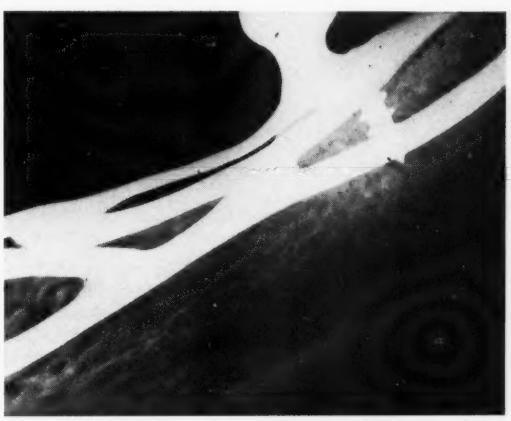
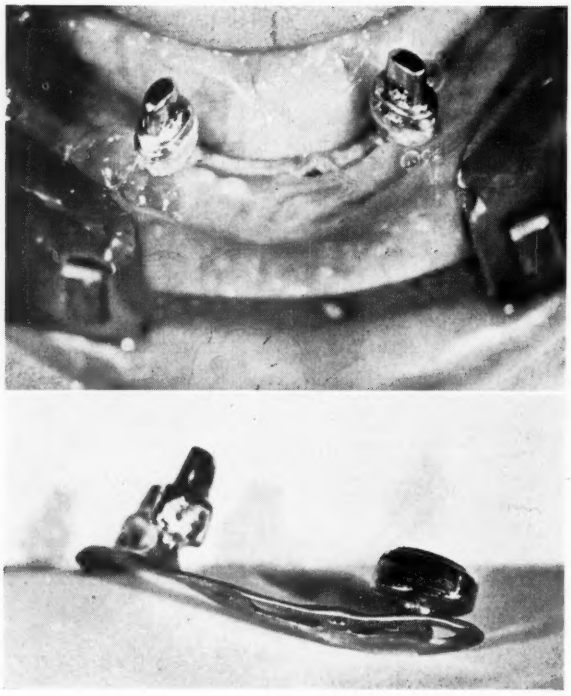


Fig. 4.—The roentgenogram shows an implant and screw 3½ years after insertion. There is no evidence of bone resorption. If the implant substructure is properly extended and accurately fitted to avoid movement and torque, no bone resorption around the implant is evident.

had gained weight, she was eating with comfort, and, for the first time since the extraction of her teeth, she was really enjoying life in general. The tissue remained healthy not only around the posts but throughout the mouth. Three and one-half years after insertion, the teeth and acrylic resin bases were removed from the superstructure and the occlusion was re-established with new teeth. This was done as a precautionary measure because I would not have the opportunity to see this patient for approximately 2 years, since she had moved away from the Chicago area. Her local dentist was seeing her for prophylactic purposes about every 3 months. Seven years after insertion (Fig. 3, *F*), periodontal membrane explorers disclosed a normal gingival crest which was negative to subgingival irrigation tests.

A roentgenogram of an implant and screws 3½ years after the operative procedures is shown in Fig. 4. If the substructure is accurately fitted to the ridge with no distortion, no overload, and adequate extensions to prevent torque action,

A.



B.

Fig. 5.—*A*, This implant was removed 3½ years after insertion because bone had resorbed under it, pockets existed around the abutment posts, the lingual part of the implant frame was exposed, and it was mobile. *B*, Incorrect design of the implant was the cause of failure. The flat substructure could not resist torque. It has inadequate extension to provide load distribution and prevent lateral movement. Compare this design with the implant in Fig. 2. This is a professional error and not a failure of the principles of implantodontics.

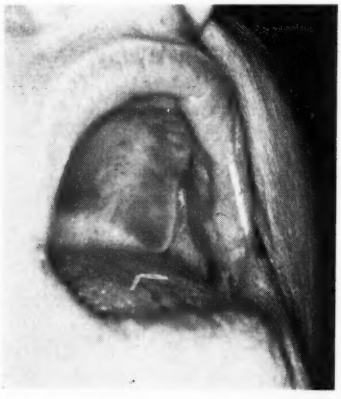


Fig. 6.—The symptoms of metabolic dysfunction responded to high protein and vitamin C and B complex therapy. An implant was not necessary.

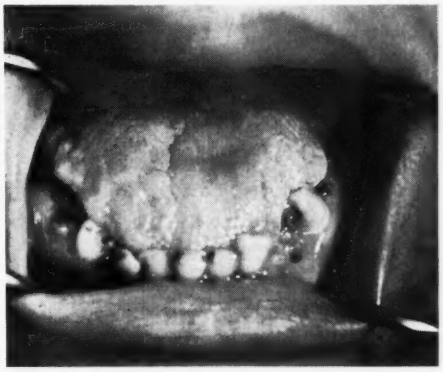


Fig. 7.—Typical oral symptoms in a diabetic patient referred for an implant. Note the festooned lateral borders and the smooth surfaces on the tongue.

there is little or no detectable resorption, either around the implant or around the screws. The function of the screws is only that of retaining or stabilizing the implant during the first 6 weeks of mucoperiosteal reattachment. After that time, the screws are not functional and are not under stress, and, consequently, bone does not resorb around them. However, if the casting is not accurately fitted or if the screws are under stress because of a lack of adequate extension to prevent torque, the stresses will cause bone resorption.

The reason for failure of the implant shown in Fig. 5 is self-evident. The flat, pancakelike design of this substructure makes torque inevitable. This implant was doomed to failure by the design of the implant prior to its insertion. Compare the flange extensions and load-bearing areas of this with Fig. 2. The failure of this

Fig. 8.—A roentgenogram of a patient after a complete physical examination with negative findings. Note the absence of the lamina dura and the decreased density of the interseptal bone (no periodontal pockets were present). Blood sugar, glucose tolerance tests, protein-bound iodine determination, and radioisotopes disclosed a subclinical diabetes and a hypothyroid condition. If an implant had been inserted, an unfavorable prognosis could have been expected.

case was completely unwarranted because the oral surgeon and the prosthodontist were employing a design that was obsolete at the time of construction. Failures of this type are failures by the profession rather than failures of the principles of implantodontics. They are damaging to the cause of implantodontics and delay the wholehearted support of the men in the profession.

The patient shown in Fig. 6 was referred as a possible implant prospect. The inflammation under conventional dentures had persisted even though four different denture materials (one with a metal palate) had been used. No allergy to the denture-base materials existed and no implant was necessary. The red mucosa and tongue, the angular cheilosis, engorgement of the blood vessels at the outer canthus of the eye, and the red color of the nasal mucous membrane are signs of metabolic dysfunction.[3] The patient was placed on a high protein diet supplemented with vitamin B and C therapy.[4] Within a month, all of the symptoms disappeared. No implant was necessary, and if one had been made prior to the proper diagnosis, it would have failed because of the patient's physical condition.

The patient shown in Fig. 7 was referred for removal of the remaining lower anterior teeth, with the suggestion for an implant. The glossy appearance of the dorsal surface of the tongue and its festooned borders were noted. Roentgenograms disclosed a lack of lamina dura. Blood sugar and glucose tolerance tests were made, and the patient proved to be diabetic even though the urinalysis was negative. I shudder to think of implant procedures undertaken under such circumstances.

The patient shown in Fig. 8 was referred after a complete physical examination for the detection of a possible focus of infection, because the patient "lacked pep and tired easily." The lamina dura was absent, and there was no trauma. The periodontal pockets were not as deep as the roentgenograms seemed to indicate. Blood sugar and glucose tolerance tests, protein-bound iodine determination, and radioisotopes revealed a subclinical diabetes and hypothyroidism even though the urinalysis was negative and the basal metabolic rate was within the normal range. Within 1 month under medication, the patient's condition returned to normal. This case should emphasize the need for a careful medical history and examination and a proper evaluation from a diagnostic standpoint prior to instituting implant procedures. An implant would have failed miserably if it had been inserted under these circumstances.

CONCLUSION

Implant dentures can be and are successful if *all* phases of the service, including diagnosis, design, surgical operation, prosthetic treatment, and postoperative care, are carefully handled.

REFERENCES

1. Goldberg, N. I., and Gershkoff, A.: The Lower Implant Denture, D. Digest **55**:490-494, 1949.
2. Doner, A. G.: Medical Evaluation and Diagnosis of the Implant Patient, J. Am. A. Implant Den. To be published.
3. Spies, T. D.: Some Recent Advances in Nutrition, J.A.M.A. **167**:675-690, 1958.
4. Stein, G., and Gold, H.: Correlation Between Gross Appearance and Histopathology of the Tongue, Oral Surg., Oral Med. & Oral Path. **8**:1165-1178, 1955.

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IMPLANT DENTURES: SURGICAL—UNFAVORABLE—QUALIFIED

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WHILE I AM LISTED as being on the unfavorable side of the presentation of this subject, it should be noted that I have added "qualified" to the title. Actually, I am neutral. I feel that implant dentures are still in the experimental stage. In my opinion, they are neither as bad as the opponents say they are, nor as good as the proponents claim.

In my experience, each patient had many dentures made by either qualified dentists or prosthodontists, and all of them had "desperate cases." By that I mean, they were willing to try anything in an attempt to get something which would enable them to masticate with a reasonable degree of comfort and efficiency.

We were very careful to select those patients who had had many failures with conventional dentures. In addition, we frankly informed these patients that as far as we were concerned, this method was still in the experimental category. We could promise them nothing. We went into detail regarding the expense and surgical procedures involved. We would attempt this treatment only if the patient was willing to sign a statement to the effect that he understood that this was purely an experimental type of procedure and that we would not be responsible for any failures or complications which might ensue. It is obvious that this explains why we have had a limited number of implant denture patients. But, I honestly could not do otherwise.

I have performed the surgical procedures for eight complete mandibular implants and one maxillary implant. The prosthetic work was done by Dr. Irving Zimmerman of Pittsburgh. In addition to these nine implants, I have followed up and treated 3 other implant patients. Two of these had complete mandibular and 1 had partial maxillary implants. Two of these last three implants were inserted by one of the members of this panel. One of my associates† has inserted three complete mandibular implants and one maxillary implant. These are included in Table I.

The complications involved with the partial failures are: (1) repeated superperiosteal abscesses with one complete mandibular and one complete maxillary implant, (2) pain and discomfort with one complete mandibular implant, and (3) pyogenic granulation tissue around the posts of one complete mandibular implant.

Presented before the Section on Implant Dentistry at the Centennial Session of the American Dental Association, New York, N. Y.

*Professor and Chairman, Department of Oral Surgery.

†Dr. Sidney S. Spatz.

When these "partial failures" will become "complete failures" is open to speculation, but on the basis of my experience, it is merely a question of time. However, even on the basis of this admittedly limited personal experience with its high mortality rate of 50 per cent, I am still impressed with the potentialities of this service in those cases in which complete failure has followed conventional methods of treatment.

TABLE I. VITALLIUM IMPLANTS INSERTED OR OBSERVED

TYPE OF IMPLANT	NUMBER OBSERVED	COMPLETE FAILURES	PARTIAL FAILURES*
Complete mandibular	13	2	3
Complete maxillary	2	1	1
Partial maxillary	1	1	0
Total	16	4	4

*These implants are still in position and functioning.

UNSUCCESSFUL IMPLANTS—CASE REPORTS

Case 1.—In our series of eight mandibular implants, the first one was inserted 7 years ago. This one was removed within the last 3 months because it was floating in a multinodular mass of hyperplastic inflammatory tissue.

In spite of what might be called a failure, the patient is insisting upon having another implant denture made and inserted; she states that she would be perfectly happy if she does not get any more than 7 years' service out of the second implant. So, one might wonder whether or not you could call this implant a failure. Certainly, it is a failure from the standpoint that the implant became loose and eventually would have sloughed out if we had not removed it. But from the standpoint of the patient, she feels that she has had value received, and she is willing to expend the same sum of money and go through the surgical operation to have a second implant made and inserted.*

Case 2.—The second complete mandibular implant lost was in place for only 29 months. However, we are told that this is the type of case which we should never have undertaken in the first place. In other words, an implant denture was inserted on an edentulous mandible, and the mandibular denture was in occlusion with the full complement of the patient's own maxillary teeth.

Case 3.—A third complete mandibular implant we certainly cannot consider as successful. We found it necessary to cut out one section from the right molar area of the implant because of chronic infection and discharge of free pus. However, this patient has a low threshold for pain and was not a favorable candidate for this service. This case is one which slipped by in spite of our better judgment, and we were doomed to failure before we started. While the rest of the implant has been, to us, perfectly satisfactory for the past 5½ years, the patient is a chronic complainer and suffers, so she says, all sorts of pain. However, it is of interest to note that she still wears a lower denture on the implant.

Case 4.—Our one maxillary implant, now in place for six years, has caused a series of buccal abscesses in the right maxillary quadrant and in the palate. We have repeatedly incised and

*This patient had the second implant inserted 10 months ago, and the implant is again proving very satisfactory.

drained these abscesses. We have even exposed the strut work for considerable distance in all directions, using a radiosurgical loop, thinking that this may put a stop to the drainage. In each instance, the mucoperiosteal membrane grew back over the struts and subsequently local abscess formation occurred. However, the implant is still very firm, and the patient is wearing her maxillary denture and is reasonably happy with it.

This patient had fifteen full maxillary dentures made of all types of material over a 16 year period. Her complaint was a continuous burning pain in the anterior part of the maxilla, for which I twice avulsed the nasopalatine nerve, and a deep-seated vicelike pain in the maxilla.

Case 5.—One of my associates* removed a complete maxillary implant from a 70-year-old man, because the implant was loose, partially exposed, and contained in grossly inflamed hyperplastic tissue. He had inserted the implant 4 years before.

Case 6.—One implant was a partial maxillary implant with three anterior teeth on it. This implant had been inserted approximately 6 years previous to the time when we first saw the patient. He reported to the clinic because he was having a discharge of pus from about the necks of the anterior abutment posts. Examination revealed the labial mucosa to be hyperemic and edematous, and pus could be freely expressed. Because the implant was still very firm, we felt that we might prolong its usefulness by reflecting the labial mucosa to expose the metal framework and remove the labial flange from it. The framework consisted of a rather fine mesh as evidenced by roentgenograms. This surgical procedure was carried out successfully. The flow of pus ceased. However, a year later, this patient reported to the clinic again. At this time, the implant was quite loose, pus again was freely expressed from around the teeth, and the palatal mucoperiosteal membrane was quite edematous and painful to pressure. At the patient's request, we removed the implant. The patient was a dental technician, and he understood that the implant was put in on an experimental basis. He was perfectly willing that the implant be inserted in such a manner because the teeth on either side of the lost ones were sound teeth, and he was not anxious to have these teeth cut into for the insertion of a fixed restoration if there was some possibility that the implant might suffice. He did have 6 or 7 years' service with it, but at present, although we have offered to make him another implant on a purely experimental basis, he has decided he would prefer to have a fixed partial denture.

Case 7.—Another complete lower implant was inserted about 5 years before we first saw the patient. This patient was examined because it is the policy of this hospital to make an oral examination of all new patients. The oral examination revealed this mandibular implant was in perfectly normal soft tissue, and the patient had no complaints. In fact, he was greatly pleased with the implant and denture. One year later, however, the patient reported back to the clinic because of a subperiosteal abscess in the lower right molar area, between the first and second abutments on that side. The abscess was incised and drained. Three months later, a subsequent abscess was also incised and drained. We have not seen this patient for a year, because he was transferred to another state.

We were interested in the fact that this implant had gone approximately 6 years without any difficulty when the abscess developed about the abutments and between the abutments.

Case 8.—Another patient who came to our attention was a diabetic who had a complete mandibular implant. This 43-year-old white man had the implant inserted in another hospital in another city in February, 1958. He came into our clinic because of irritation around the right posterior abutment. He was very fearful of trouble if he did not have this taken care of, because he was afraid he might lose his implant. We felt that this mucosal irritation was due to a poorly fitting superstructure. We removed the pyogenic type of granulomatous tissue with a radiosurgical loop, and we referred him to the prosthetic division for correction of the poor occlusion. This was done. He is to return, if possible, to the original hospital so that the dental division in that hospital and the dentist who made the implant can see the situation. Perhaps, a new superstructure can be made so it will occlude properly with the denture.

*Dr. Sidney S. Spatz.

This is a total of eight complete or partial failures out of sixteen implants that I have, personally, either helped to insert or have followed up subsequent to the insertion by other dentists. It is evident why I have qualified my disapproval. We should not stop attempting to correct the shortcomings of implant dentures simply because we have lost some of them. The patients' acceptance of these dentures and the satisfaction they get from them certainly should encourage us to continue to seek and find, eventually, the answers to the shortcomings of implant dentures. They certainly have the shortcomings which I have reported. The shortcomings are that sooner or later these implants do become loose, the tissues break down, and localized abscesses form. The abscesses spread from one area to another and, eventually, the implant is sloughed out. The maximum time we have had a full lower implant in place is 7 years, but I understand there are some patients who have had them in place for 10 years. I am not disputing that this may be true. I, personally, have not seen any that were in 10 years, and I would like to see one. I hope that there is a large percentage of them that stay in for 10 years. But, in our experience, 6 or 7 years seems to be the maximum length of time for them to stay in position. In one instance, we lost a complete lower implant in 2½ years.

We should still label this procedure for what I honestly think it is, namely, an experimental procedure. If we do this, we cannot be accused of anything other than an honest attempt to find the satisfactory answer for unfortunate individuals who cannot handle dentures borne on soft tissue.

SUCCESSFUL IMPLANTS—CASE REPORTS

All of the other eight mandibular implants, so far, are firm with no indication of any looseness, and there have been no abscesses about them. All of the patients are quite happy with these implants in spite of the fact that in two of them some of the substructural material is exposed in the oral cavity.

Case 1.—For 20 years, this 53-year-old female patient has had trouble with dentures. She has had ten complete upper and lower dentures. She complained that she could not keep the lower denture in, she could not eat with it, and, when she did have it in, she had difficulty with her speech. She was completely unhappy. On Sept. 4, 1953, the first surgical procedure was carried out. The mandible was exposed, an impression was made, and the soft tissues were closed. On Oct. 12, 1953, the second operation was carried out in which the implant was inserted. Three screws, one in the symphysis and one in each of the third molar areas, were used to hold the implant in position during healing of soft tissues. A splint was placed upon the abutments after the soft tissues were sutured in place. The soft tissues healed very well. There was no opening along the line of closure, and on Nov. 27, 1953, the superstructure was completed and inserted. The patient was very happy. She could eat anything, and she had no trouble with her speech. We have not heard from her for several years because she moved out of the state, but she promised that if she had any difficulty, she would get in touch with us and advise us of her difficulty. Since we have not heard from her, we consider that this implant is still a successful one.

Case 2.—This 46-year-old woman had been edentulous for 3 years when she came to us in July, 1953. She had the usual complaints. She simply could not wear her lower denture. She had pain and could not eat or talk with it. Five sets of complete dentures were uniformly unsuccessful. They had been made in the past 3 years by different men of outstanding ability. A

year prior to her visit to us, she had had surgical operation on the mandible (possibly an alveolectomy) in an attempt to improve it so she would not have so much pain and discomfort when she attempted to eat. This, however, was unsuccessful. In December, 1953, the first surgical procedure was carried out. The mandible was exposed by reflecting the labial, buccal, and lingual flaps of the mucoperiosteum. An impression of the mandible was made; then, the soft tissues were replaced and sutured to position. Four weeks later, a complete lower implant was inserted and secured to the bone with three screws. This was followed by suturing the soft tissues over the substructure. An immediate splint was placed on the abutments to protect the implant. When the sutures were removed, the metal substructure was exposed anterior to the cuspid post and in the left molar area. The left molar area subsequently became covered with soft tissue, but the struts are still exposed in the anterior region between the cuspid posts at the midline. They have been this way for several years and have given no trouble.

Case 3.—This 39-year-old woman became edentulous at the age of 21. She had had five complete upper and lower dentures since then and reported excruciating plain in the mandible, no retention, and inability to chew or talk. On March 10, 1955, the first surgical procedure was carried out. The mandible was exposed by reflecting the soft tissues, an impression of the mandible was made, and the soft tissues were closed over the mandible. Four weeks later, the bone of the mandible was exposed again, and the implant was inserted and fixed to the mandible with three screws. After this, the soft tissues were replaced and sutured in position. A splint was placed on the abutments to protect the soft tissues and to hold the soft tissues in place, to some degree, during healing. Six weeks later, the permanent superstructure was inserted. This patient is very happy. She can now eat and talk and has been completely rehabilitated. The soft tissues are still in excellent condition.

Case 4.—This 45-year-old woman had been edentulous for 10 years and had had five complete lower dentures. Her condition was becoming progressively worse. She could not eat or talk, and she had the usual complaints of pain in the mandible. On Nov. 3, 1955, the first procedure was carried out. Impressions of the mandible were made and the soft tissues replaced and sutured. On Dec. 4, 1955, the second operation was carried out, in which the implant was inserted. A splint was placed over the abutments to protect the soft tissues. The final superstructure was inserted on Feb. 13, 1956. The patient is exceptionally well pleased. She eats everything and is an entirely different person—very happy with her implant denture.

The remaining four successful complete mandibular implants all had similar stories and, so far, very satisfactory results.

CONCLUSION

Complete implant dentures should be considered as a legitimate, worthy, and necessary project for continued clinical research.

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IMPLANT DENTURES: PROSTHODONTIC—FAVORABLE

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IT IS FITTING TO PAUSE FOR A MOMENT and look back, consider, and evaluate the most radical and at the same time most far-reaching and promising development in prosthodontics in the last decade, the implant denture.

Attempts to replace missing teeth by implanting into the alveolar process a more or less toothlike alloplastic material to carry a crown or fixed prosthesis have been made with limited success for at least 100 years. These attempts can be dismissed with the statement that, although the procedure is interesting, further research is needed, and so far no conclusive success has been attained.

The implant denture, especially the mandibular complete implant denture, is entirely different and deserves the closest attention. In 1938, Gustav Dahl of Stockholm inserted an appliance bearing some resemblance to an implant denture. In 1943, Robert Killebrew of Des Moines seriously considered supporting a complete denture by a metal base implanted against the residual ridge under the mucoperiosteum. However, full credit must go to Norman Goldberg and Aaron Gershkoff[1] of Providence, Rhode Island, who developed and in November, 1949, published a rudimentary technique by which implant dentures of limited success had been made (Fig. 1).

The first half of the 1950s was a period of rapid development during which many aggressive dentists, unfortunately not always of sound technical and theoretic ability, were attracted to the idea. By a process of trial and error during which many mistakes were made, the unqualified dentists and those with transitory interest in implants stopped working with them. Other dentists gradually developed sound, accurate techniques and materials. The American Academy of Implant Dentures (a small group of enthusiastic and dedicated dentists who met twice a year to report progress and exchange ideas) made this rapid development possible.

The last half of the 1950s was a period of slower refinement, evaluation, and development. Many outstanding prosthodontists and oral surgeons and a number of teaching hospitals and dental colleges were gradually attracted to the idea by the evidence of the many enthusiastic patients who have had healthy and efficient implant dentures for a steadily increasing number of years.

Unfortunately, many other dentists, among them some recognized authorities, continue to oppose the idea of prosthodontic implantation, often basing their decisions on obsolete theories or casual observation of the inadequate techniques and frequent mistakes of the early experimental period.

Presented before the Section on Implant Dentistry at the Centennial Session of the American Dental Association, New York, N. Y.

Today, it is difficult to understand or condone this attitude. After Orville Wright at Kitty Hawk in 1913 flew 120 feet or even after the first flight across the United States in 1911 in 82 hours (not counting time out for 68 stops), one might have been justified in concluding that the airplane could never compete successfully with the railroad for swift, safe, and comfortable travel across our continent or with the luxurious steamship for travel between Europe and America.

Who, considering the progress in pharmaceuticals, doubts that tuberculosis and poliomyelitis can be controlled? Who, studying the recent advances in medicine such

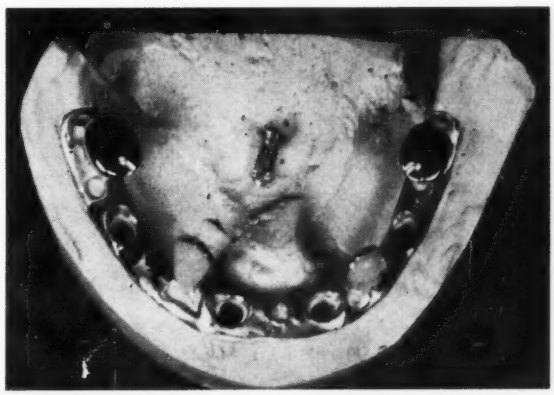

Fig. 1.—A crude implant denture made during 1949-1950.

as open heart surgery with the implantation of alloplastic heart valves, is skeptical of eventually finding cures for cancer? Who believes it impossible that someday artificial limb prostheses may be activated by remaining muscles to produce controlled hand and finger function?

Is dentistry any different? Are we never to offer the edentulous patient with a resorbed ridge anything better than a denture which transmits masticatory stresses entirely to the tender oral mucosa, which is subject to displacement or irritation of the border tissues with every cheek and tongue movement?

Of course not! Our present implant dentures, successful as they are, are only the beginning; but they are a gigantic stride forward. What thinking dentist would want to go on record as predicting that it is impossible for an improved implant denture to become an accepted method for restoring masticatory efficiency and comfort to edentulous patients?

NUMBER OF IMPLANT DENTURES MADE

Since 1949, 100 members of the American Academy of Implant Dentures have inserted about 1,000 implant dentures (Table I). Other American dentists probably have made another 1,000 implant dentures. Judging by the attendance and presentations at international meetings and by published works in many languages, among dentists throughout the rest of the world 2,000 more implant dentures probably have

been made. Of this total, estimated to be more than 4,000, it can be reasonably expected that three-fourths are still in place.

To visualize how good these results really are, it is important to remember that these figures include the first primitive implant dentures ever made, many early crude implant designs, the first attempts of inadequately informed dentists, and a great many now recognized serious technical deficiencies. If consideration is given only to the more recent implant dentures made with a direct bone impression by dentists experienced and qualified in the implant denture field, the number of implant dentures that are still successful would approach 100 per cent, with only a negligible number of patients who ever show a serious deficiency.

Since so many successful implant dentures have been made, why have dentists been so slow to accept them for more general use? There is a natural tendency for everyone to resist things which are foreign and opposed to their long-established thinking. It is true that the implant denture does require a new and different approach. It is as distinct and removed from conventional prosthodontics as the airplane was from the accepted surface transportation in 1920.

TABLE I. ESTIMATED NUMBER OF IMPLANT DENTURES INSERTED

Members of American Association of Implant Dentures	1,000
Other American dentists	1,000
Dentists in other parts of the world	2,000+
Total	4,000+
Probably still in place	3,000

I have been associated with the preparation of thirty implant dentures in the last 8 years, averaging almost four per year. A detailed follow-up by mail in July, 1959, was 100 per cent complete. Twenty-three of these thirty implant dentures have been in place from 2 to more than 7 years (Table II).

Analyzing these results critically from the standpoint both of the patient and of the dentist, twelve seem to be nearly perfect and are rated "excellent"; seven, which have minor deficiencies considered to have little or no detrimental effect on the prognosis, efficiency, or patient comfort, are graded "good"; two have more serious deficiencies which, although not seriously unfavorable at present, conceivably could require removal in future years, and are considered just "fair." Only two, or less than 7 per cent, of my implant dentures have been removed, one after 5 years and one after 3 years. It is noteworthy that 87 per cent of the thirty implant dentures are either excellent or good and show no deficiencies expected to unfavorably affect their long-term prognosis.

Of the twelve implant dentures graded excellent, one made in 1952 has been in place nearly 8 years and nine others have been in place from 4 to 7 years. Of the seven graded good, two have been in place more than 6 years while three others are 4 to 6 years old. Both "fair" implant dentures were made in the same period 5 years ago.

Of the two implant dentures that have been removed, one (my first bone impression denture, made in 1952), was removed after 3 years because of a break in the substructure framework. It was replaced with a modern implant denture which is considered excellent after more than 5 years. The other was removed after 5 years, because of recurring chronic inflammation around one of the posterior abutments, and replaced with a satisfactory soft tissue–borne denture. The residual ridge was smoothly rounded and made a better conventional denture foundation than it would have before the implant surgical procedures.

COMPLICATIONS

Infections Beginning Around the Abutment Epithelial Penetration.—This is the problem still worrying most dentists when they think about implant dentistry. Westerberg and Clark[2] have discussed this thoroughly. They suggest that the block-

TABLE II. EVALUATION OF TWENTY-THREE IMPLANT DENTURES BY QUALITY RATING AND NUMBER OF YEARS IN PLACE

NUMBER OF YEARS	EXCELLENT	GOOD	FAIR	REMOVED	TOTAL
7–8	1				1
6–7	1	2			3
5–6	2	1	2	1	6
4–5	3	2			5
3–4	3			1	4
2–3	2	2			4
Total	12	7	2	2	23

age of the entrance to bacteria and of the escape of body fluids at the implant abutment may be due to tightening of the epithelial cuff without direct attachment and to the fact that pathologic bacteria which enter the abutment crevice are eliminated by a physiologic process of dilution, mechanical washing, and normal body defenses. This is the same as around an erupting tooth or an artificial crown or pontic root which extends below the gingival margin.

In general, I believe that the oral tissue around the implant denture abutment can be maintained as healthy as around a natural tooth in a similar situation. Clinically and functionally, the tissue around the average oral implant penetration is healthy. In spite of all the worry and associated pessimism, the mucosal penetration does not seem to be the decisive factor in the success or failure of the implant denture. When occasional inflammations do occur, they are limited to the soft tissue, and serious cellulitis or osteomyelitis does not seem to develop.

Secondary Exposure of the Implant Substructure.—A breakdown of the oral mucosa over the implant substructure, with undesirable exposure of the metal framework, is the most common problem associated with implant dentures.

When exposure develops in the suture line after insertion, it is because metal of the substructure framework has been placed under or close to the incision line.

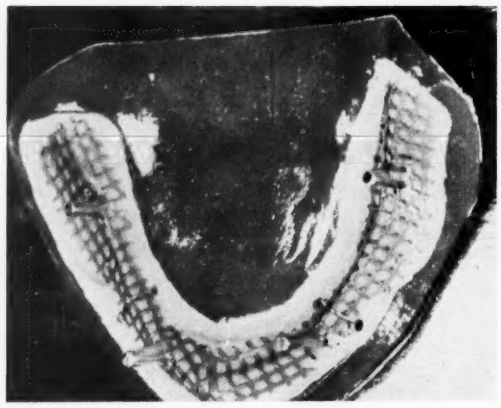

Fig. 2.—An implant inserted in September, 1952, with a meshwork substructure (patient A).

This is easily avoided by proper design of the substructure so that the metal is kept away from the crest of the residual ridge.

If the metal is closely adapted to the bone (0.5 mm. or less), the tissue will slowly granulate over the exposed metal and complete the coverage without a connecting fistula.

If there is a poor fit of the substructure against the bone (a space of 1 mm. or more), oral epithelium may regenerate under the metal so that a permanent substructure exposure may develop. Even this type of exposure tends to improve, growing slowly smaller over many months, and may become completely covered after a year or more.

Secondary metal exposures, if reasonably small in extent, are undesirable but not particularly unfavorable for the prognosis of the implant. As conditions can be kept healthy around the abutments, so can they be kept healthy around additional metal exposures.

The problem of secondary metal exposure is gradually being solved by close attention to technique. Proper surgical procedures will prevent secondary healing in the incision line. Obtaining an accurate impression of the bone will ensure a perfect fit of the implant against the bone. Correct design of the substructure will avoid those areas where mandibular bone changes may be anticipated.

The ultimate success of the implant denture depends upon the ability of the underlying mandibular bone to withstand, for many years, the stresses of mastication transmitted by the implant substructure. The main support of the implant must come from the external oblique ridge and the superior part of the mylohyoid ridge and from the symphysis of the body of the mandible. The implant substructure, because it is to fit against living bone, must be designed with the anticipated bone changes in mind.

The implant substructure rapidly becomes encapsulated in tough fibrous connective tissue. The portion of this connective tissue that lies between the substructure and the bone is able to withstand the intermittent masticatory pressures.

While some changes in the living mandibular bone must always be expected and much more remains to be learned about them, the mandibular implant denture

is successful. The fear that serious infection would enter the body at the site of the abutment penetration has been unwarranted.

The place of implant dentures in prosthodontics will be determined when, after a great deal more experience, evaluation is possible for each patient. Then the number of years of expected implant denture efficiency and comfort can be weighed against the surgical discomfort and expense involved. The patient, aided by the judgment and experience of the dentist, must decide.

Since an implant denture which served adequately for as little as 3 years cannot be called a complete failure, neither can one which lasted for 20 years necessarily be called a complete success.

PATIENT HISTORIES

Everyone who has followed or worked with implant dentures from their early beginnings is familiar with mistakes, remarkable successes, and some failures. There are many successful, comfortable, and remarkably efficient implant dentures which have been completely healthy for a number of years. The literature, clinics, and lectures in recent years have demonstrated so many excellent examples of successful implant dentures that it seems almost unnecessary to add more.

Fig. 3

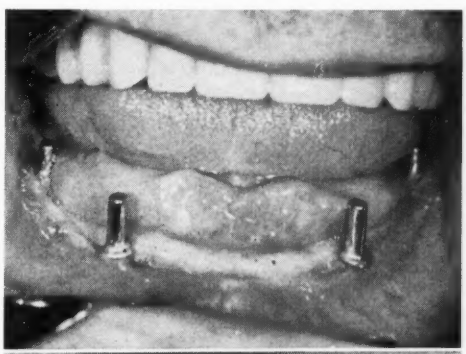

Fig. 4

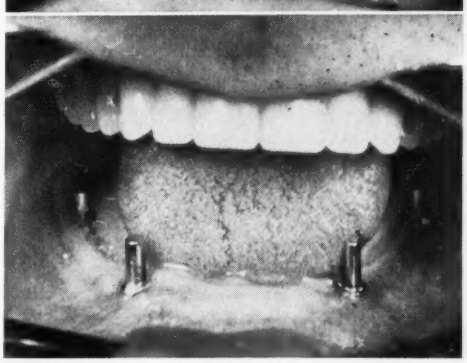

Fig. 3.—The breakdown in the suture line mesial to the left anterior abutment with metal exposure occurred 2 weeks after insertion (patient A).

Fig. 4.—Six years after insertion, there was only the slightest suggestion of defect mesial to the left anterior abutment (patient A).

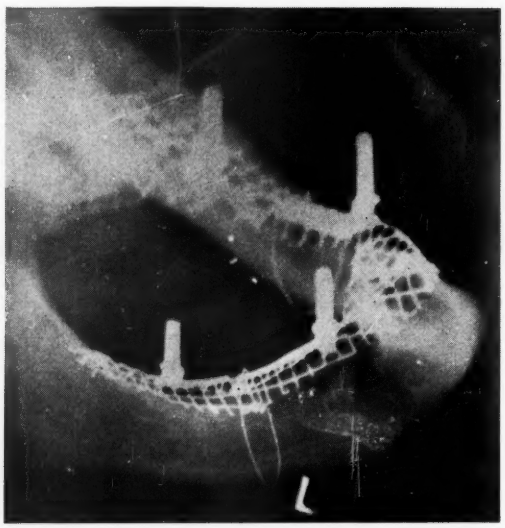

Fig. 5.—A roentgenogram made 6 years after insertion; note the healthy bone (patient A).

Patient A.—My second bone impression implant denture, inserted in September, 1952, is perhaps my most important work. It is now 7 years old. The patient, aged 40, had been begging for an implant denture ever since he had seen the results for the previous patient.

It was the second of only two that we made with the "all-over" meshwork substructure. While today this meshwork type of implant is generally considered obsolete, the 7 year near perfection obtained in this patient may indicate that this construction should be re-evaluated (Fig. 2).

Postoperative swelling resulting from invasion of muscle attachments by such traumatic mucoperiosteal elevations often caused a breakdown in the suture line, with subsequent healing by granulation (Fig. 3). Healing was rapid, however, and at 2 months only a small line of metal could be exposed by a blast of air, just mesial to the left anterior abutment.

In April, 1958, almost 6 years after its insertion, only the slightest suggestion of an opening remained, just mesial to the left anterior abutment, in the area which granulated and closed slowly after the insertion (Fig. 4). Roentgenograms revealed healthy bone and no apparent bone resorption. The circumferential wiring was still in place with no change in position (Fig. 5).

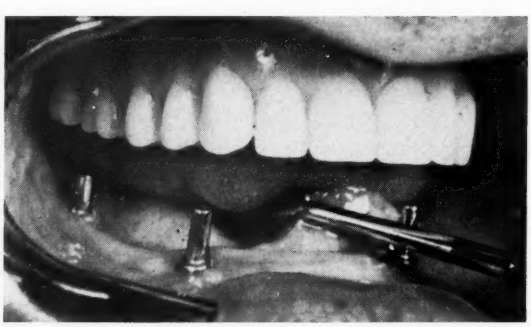

Fig. 6.—The implant 7 years after insertion; this implant denture will withstand the closest scrutiny of the severest critic (patient A).

The bone impression was made entirely in modeling plastic, and I remember that the fit was not accurate on the lingual side on the left. However, this has not caused the slightest difficulty; there is no exposure and there is no metal reflecting through the mucosa.

This patient believes that his implant denture has been a big factor in maintaining his general health and enabling him to perform his military duties without mouth discomfort. He points out that before this implant denture was made, he had had five sets of ordinary dentures all of which he could barely tolerate. It solved his problems perfectly.

This implant denture, my oldest and perhaps most successful, was 7 years old in September, 1959. While it cannot be considered technically comparable to the implant dentures we make now, it has improved continuously and promises many more years of denture comfort and efficiency. I examined this patient in February and May of 1958 and have corresponded with him recently. It is a nearly perfect implant denture which will favorably withstand the closest scrutiny of even the most severe implant critic (Fig. 6).

Patient B.—More recent implants made by adequate techniques have generally been without complications. An implant denture inserted in 1954 featured two extra rest penetrations between the abutments on each side to more equitably distribute the masticatory stresses throughout the implant substructure (Fig. 7).

An adequate impression technique with polysulfide rubber produced an exact and snug fit against the mandibular bone so that no screws were used.

Unusually rapid healing produced complete mucosal coverage in 2 weeks with no untoward developments. The patient was masticating adequately on the immediate temporary superstructure, which he insisted was already more efficient and comfortable than any ordinary denture he had ever had.

This patient has been followed up regularly for 5 years (Figs. 8 and 9). He has been most enthusiastic about the procedure. He insists he has never had even the slightest discomfort, irritation, or inflammation anywhere in his mouth.

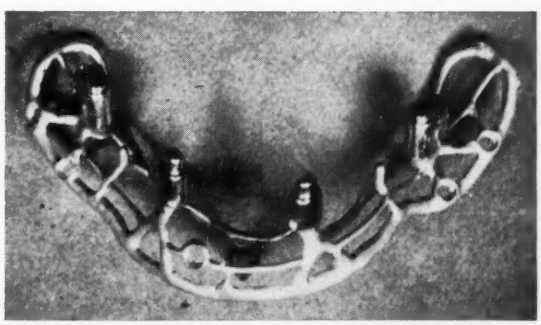

Fig. 7.—This implant substructure with rest penetrations between the abutments on each side was inserted in 1954 (patient B).

Patient C.—An implant denture with four abutment and three rest penetrations was made in 1955 for a patient aged 40 who had been edentulous for 8 years without ever having received a comfortable denture (Fig. 10). As he put it, his lower dentures served only for "cosmetic" reasons.

Healing was complete at 4 months. Adequate evaluation of the three extra "secondary rests" depends on whether the advantages of more equitable stress distribution outweigh any possible disadvantages from the three extra penetrations of the mucosa.

Two years later, this implant denture was nearly perfect, with the oral conditions possibly even more healthy around the small secondary rests than around the larger primary abutments

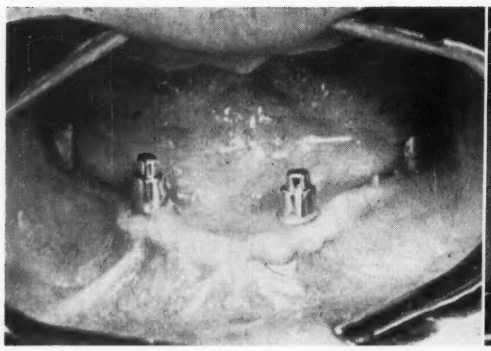

Fig. 8

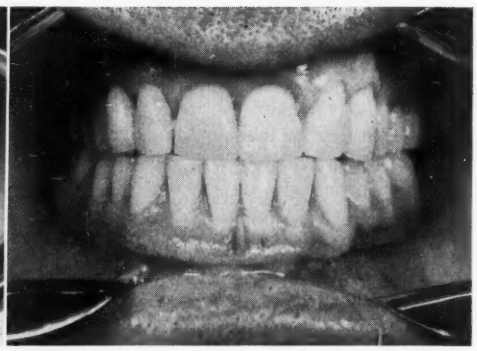

Fig. 9

Fig. 8.—The patient has been without the slightest discomfort, irritation, or inflammation for 5 years (patient B).

Fig. 9.—The implant denture wtih the superstructure in place is more comfortable and efficient than any mucosa-supported denture (patient B).

(Fig. 11). Certainly, everyone should agree that this implant denture is a healthy success and a blessing to this patient. A letter of August, 1959, 4 years after insertion, reveals that there are no secondary metal exposures and that there is no inflammation.

Patient D.—An unusual patient was referred in March, 1957, by the Dental Director of the National Institutes of Health. She arrived with a sack of old dentures in her hands as mute and pathetic evidence of prosthetic dentistry's failure with her (Fig. 12).

Fig. 10

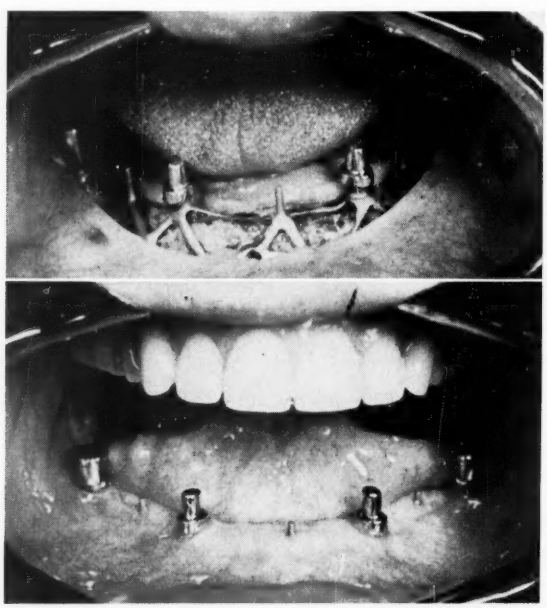

Fig. 11

Fig. 10.—This implant substructure with three rest penetrations between the abutments to equitably distribute superstructure stresses was inserted in 1955 (patient C).

Fig. 11.—Note the healthy conditions around four abutment and three rest penetrations (patient C).

After unsuccessful treatment for a year at the National Institutes by the Medical, Dental, and Psychiatric Departments, she was referred to me for an implant denture as a last resort. In her desperation, she had developed suicidal tendencies which caused the Institutes to fear for her life unless something could be done to give her oral comfort.

After the insertion of a successful implant denture, she was able to resume her work and hold a responsible job as a civil service employee.

In September, 1959, I studied a recent roentgenogram of the underlying bone, which was normal. Needless to say, this patient is perhaps the world's greatest booster of implant dentistry. While her problem undoubtedly was psychologic as much as physical, she had received some of the best prosthodontic aid in America and England. The implant denture may have saved her life.

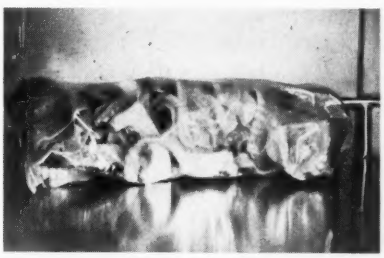

Fig. 12.—The sack of old dentures presented by the implant denture patient as pathetic evidence of prosthetic dentistry's previous failure (patient D).

PATIENT ACCEPTANCE

Probably the most important factor in favor of the implant denture has been its spectacular patient acceptance. The patient who has struggled with a conventional denture and then has had a successful implant denture will support the fact that it is many times more comfortable and efficient.

The reason for this is that the implant denture transfers the stresses of mastication, through the implant abutments and the implant substructure, directly onto the surface of the bone. No pressures whatsoever are felt on the underlying mucosa. This makes the sensation of masticating on an implant denture completely different from that of masticating on a denture borne by soft tissue.

The regular 6 month follow-up letters I receive continually emphasize this point as well as the fact that the implant dentures feel almost like natural teeth to these patients. The deep sincerity and enthusiasm with which my patients have expressed their gratitude for the part the implant denture has played in making their lives more worth living has been heartwarming. It has been a most satisfying experience.

CONCLUSION

The problem is now upon us; we cannot dodge the issue. The prolonged life expectancy and the rapidly increasing percentage of people in the older age group have made geriodontics vital. It is doubtful that dentistry can ever preserve the natural teeth of all people, and it is certain that a denture that relies on the oral mucosa for masticatory support is not the final answer.

Undoubtedly, a satisfactory method must be found to utilize the maxillary and mandibular bone for direct support to produce comfort and efficiency that are impossible with dentures supported by soft tissue. The implant denture is a practical solution for the patient who cannot, or will not, wear a denture supported by soft tissue. It is the solution for the unfortunate patient who, because of excessive mandibular resorption, can obtain only negligible masticating efficiency from a properly constructed soft tissue–supported denture.

The enthusiastic patient acceptance of implant dentures practically guarantees a continuing increase in patient demand for them and professional interest in them. This is because of the remarkable increase in comfort and efficiency and the success and freedom from serious complications currently being achieved by dentists qualified in implant procedures. The implant denture deserves the immediate and continuing attention of progressive oral surgeons and prosthodontists, as well as a maximum research effort in all areas of dentistry.

Considering the success already attained and the number of successful implant dentures that have been in place 5, 6, 7, and more years in healthy mouths, it would seem that this is the right approach. Continuing rapid development may see the acceptance and general utilization of implant dentures for edentulous patients. It will bring to these patients comfort and efficiency that are not attainable with mucosa-supported dentures.

REFERENCES

1. Goldberg, N. I., and Gershkoff, A.: The Implant Lower Denture, D. Digest **55**:490, 1949.
2. Westerberg, M. L., and Clark, H. B., Jr.: Implant Dentures, J. Oral Surg. **13**:55, 1955.
3. Bodine, R. L., Jr.: Implant Dentures, Practical Dental Monographs, Chicago, 1958, Year Book Publishers, Inc.

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IMPLANT DENTURES: PROSTHODONTIC—UNFAVORABLE

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MY ASSIGNMENT ON THIS PANEL is the discussion of the unfavorable prosthodontic aspects of implant dentistry. This is not a pleasant assignment because it involves criticism of the work and objectives of some sincere and conscientious dentists. These dentists are attempting to solve some serious problems in the rehabilitation of people who have lost their natural teeth. They are using more or less unorthodox and radical methods in these attempts, but that in itself does not detract from their efforts. So, my discussion will not be a simple criticism of the theory of implant dentures, but it will point out some of the features about it which must be improved if their objectives are to be achieved.

People who lose their natural teeth want them to be replaced in such a way as to restore natural function. Many methods have been devised for satisfying this desire, and most edentulous patients appear to be satisfied by the efforts of the dental profession in this direction. However, a small percentage of edentulous patients are not happy with their dentures. These are the people who seek the services of specialists in prosthodontics. They are the people whose physical, mental, or oral condition is unfavorable for dentures. In order to satisfy their requirements for dentures, extra skill and care and accuracy of construction are necessary.

Included in this class of patients are people who have the conditions which are commonly referred to as being *"indications"* for implant dentures. But included also are those patients who have the generally listed *"contraindications"* for implant dentures.

The most commonly listed indications[1] for implant dentures include: mandibular canal on top of the bone, mental foramen on top of the ridge, unfavorable muscle attachments, extreme atrophy of the mandibular ridge, flat ridges, mutilated mouth conditions resulting from surgical operation, gagging, torus mandibularis, torus palatinus, enlarged tongue, excessively mobile tongue, intolerance to the bulk of denture-base material, instability of dentures borne on soft tissue, lack of retention of soft tissue–borne dentures, psychologic intolerance of dentures, and the patient's desire for a stable denture.

These conditions do present problems, but they *can* be solved and they *are* solved for patients by informed dentists who take the time and care necessary to adapt dentures to meet the situations involved. Patients with these conditions

Presented before the Section on Implant Dentistry at the Centennial Session of the American Dental Association, New York, N. Y.
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require more than the usual attention to the making of impressions; they must have a precisely balanced occlusion and a carefully developed arch form for esthetic appearance and for balancing the pressures between the tongue and the cheeks and lips. In other words, successful and satisfactory complete dentures borne on soft tissue *can* be made for patients who have the "indications" for implant dentures, *provided* the dentures are properly constructed.

It is obvious that *improperly* constructed dentures cannot overcome the difficulties which are listed as indications for implant dentures. The techniques and materials for making adequate dentures are available. When these techniques and materials are used efficiently, the "flat" ridges provide excellent support for dentures. However, careless execution of these techniques causes failures which lead patients to *think* that implant dentures are the only solution to their problems. It must be recognized that careless execution of implant denture techniques can cause failures also.

A number of "contraindications" for implant dentures have been listed.[1] Among these are: mouths with recent extractions, unerupted teeth, cysts, tumors, retained root tips, osteomyelitis, malignancies, spiny ridges, drug addiction, chronic alcoholism, pregnancy, radiation therapy, paralysis, epilepsy, Parkinson's disease, multiple sclerosis, diseases of the cardiovascular system, acute bronchitis, emphysema, bronchiectasis, asthma, pulmonary tuberculosis, muscular dystrophy, leukemia, Hodgkin's disease, anemia, diabetes mellitus, acromegaly, Paget's disease, cirrhosis of the liver, ulcers, colitis, nephritis, pyelitis, and old age. There are other stated contraindications, but this list will suffice to point out the fact that dental implants should not be used for many patients who have severe denture foundation problems. In fact, it appears that it is not safe or advisable to use implant dentures for the people who need them most. This is unfortunate, because there are more edentulous people in the higher age groups than in the lower age groups. Also, more of the diseases which contraindicate the use of implant dentures occur in the higher age groups.

These people need teeth too, and dentures must be made for them *in spite of* the unfavorable oral and general physical conditions that may exist. Accurately made soft tissue–borne dentures do supply usable teeth in these situations.

TECHNICAL CONSIDERATIONS

When soft tissue–borne and implant dentures are compared, it must be assumed that both types are properly and carefully constructed. If dentures borne on soft tissue are not properly constructed, they will not restore the functions of mastication, esthetic appearance, and phonetics with comfort and efficiency. If implant dentures are improperly constructed, they will fail likewise to restore these essential functions. However, if exacting care is not taken in the construction of implant dentures, serious distress is caused to the patient by the necessity of removal of the substructure of the implant. If the implanted structure is removed, it is necessary to reconstruct *both* the substructure and the superstructure or to make soft tissue–borne dentures for the patient. If a soft tissue–borne denture fails, it is only necessary to construct a new denture.

Certain technical considerations apply to both types of restorations. The vertical dimension of occlusion, the centric and eccentric jaw relations, the occlusion, and the arch form must be correctly recorded or developed for the success of either soft tissue–borne dentures or implant dentures. The problems of each of these will be discussed as they relate to both types of restorations.

VERTICAL DIMENSION OF OCCLUSION

The same limitations and requirements of the vertical dimension of occlusion apply to both types of restorations. This jaw relationship is the most difficult to establish with a certainty of its accuracy. It may be related to the vertical dimension of rest position, but this jaw relationship has been shown to vary under different circumstances.[2] The method involves the determination of the physiologic rest position of the mandible that provides an interocclusal clearance sufficient to allow the tissues supporting the teeth to rest between periods of function. An error in the vertical dimension of occlusion can have more distressing consequences for patients with implant dentures than for those with dentures borne on soft tissue. It is possible that this type of error may have contributed to the loosening or exfoliation of the substructures of some implants. Most articles on implant dentures make only cursory reference to this important phase of denture construction.

CENTRIC RELATION

An accurate record of centric relation is as important to implant denture success as it is to any other phase of prosthodontics. If it is incorrectly recorded, the occlusion cannot be in harmony with the neuromuscular system of the patient, and the restoration will fail. A failure of an implant restoration from this cause is more serious than a failure of a soft tissue–borne denture because it will cause loosening of the implant and necessitate its subsequent removal. Authors who write about implant dentures seem to pay only passing attention to the recording of centric relation.

It should be apparent that the making of centric relation records for implant dentures should be simple because the foundations for the recording bases can be so firm and stable. However, this very stability may cause a sense of false security on the part of the dentist. He may feel that since the base is so stable, the only record required is the one in which the patient closes the mouth easily. This type of record is inadequate for both types of restorations. The difference is in the fact that the results of an error in centric relation show up under soft tissue–borne dentures as soreness almost immediately, while they take longer and are more serious under implant dentures. More emphasis should be placed on the necessity for recording centric relation accurately for implant dentures.

ECCENTRIC RELATIONS

Eccentric relation records are essential for the adjustment of the articulators on which either type of denture is constructed, provided the occlusion is to be

balanced in the eccentric jaw positions. Unless the patient is one who uses only hinge closures and does not grind his teeth together, a failure to record the eccentric jaw relations and to adjust the articulator accordingly can lead to failure of either type of restoration.

OCCLUSION

An accurately balanced occlusion is conducive to the health of the supporting structures of natural teeth, soft tissue–borne dentures, and implant dentures alike. A cross-arch balance is not as important to natural teeth and *probably* not as important to implant dentures as it is to soft tissue–borne dentures. However, there is one unbalanced condition which is disastrous in all three situations. A balancing side contact, made before the teeth on the working side touch, will cause the loss of a natural tooth. It follows that this type of contact can cause the failure of implants as well as soreness under a denture borne on soft tissue. It seems that too little attention is paid to the development of an accurate occlusion of implant dentures.

ARCH FORM

Implants seem to have limitations in the development of the form of the dental arch that do not exist in soft tissue–borne dentures. The "posts" are placed directly over the residual ridge. This leads the dentist to place the other teeth in line with these posts. Consequently, the appearance of implant dentures does not seem to be as good as it could be. It should be recognized that the bone of the maxillae and mandible does not shrink in only a vertical direction. The teeth must be placed "off the ridge" in many instances to provide the proper support for the facial tissues. This *can* be done in soft tissue–supported dentures, and it *may* be possible in implant dentures. Perhaps more consideration should be given to the arch form of implant dentures so their appearance can be as good as that of soft tissue–borne dentures.

Due to the fact that the arch forms of implant dentures are not developed so the teeth are in the same locations as the natural teeth, the phonetic possibilities are not as good as they are with soft tissue–borne dentures. Also, the shape of the palatal vault cannot be altered sufficiently to improve phonation, in some instances, unless the entire palate is covered. If the upper arch form is more narrow in the denture, the palate must be made thicker so the tongue can control the flow of air for the production of speech sounds.

NONTECHNICAL CAUSES OF FAILURES

The most baffling cause of failure of dentures applies to both soft tissue–borne and implant dentures. This is the change which occurs in the bone which supports the appliance. Bone is the most plastic of the tissues of the body. Bone reacts to pressure by retreating from it.

When bone resorbs under a denture borne on soft tissue, the denture becomes loose and unstable, and it must be relined or replaced. When bone resorbs

under an implant, the implanted substructure must be removed, and the entire restoration must be rebuilt. When these appliances are rebuilt, there is no assurance that the same type of bone change will not continue.

It is possible that these bone changes are more apparent (at least in the early stages) with soft tissue–borne dentures than with implant dentures. The changes are just as real and more difficult to correct, however, with implant dentures.

ECONOMICS

There is one other very serious problem relating to the use of implant dentures which cannot be ignored. This is the problem of economics and dental manpower. The amount of work necessary to make implant dentures causes this service to be very expensive. The cost of it would prevent many who might be benefited by it from having it. This is particularly unfortunate because many of those who might be candidates for it are in the lower income bracket. They are people who have denture problems because, at least in part, of inadequate diet and inadequate dental care.

Since the procedures involved in implant denture construction amount to the equivalent of those necessary for constructing three or four sets of dentures, it is obvious that there are not enough dentists to do this type of work for all edentulous patients. This would be the situation even if every dentist was supplying this service. For these reasons, the implant denture procedure, at its current stage of development, cannot be considered as a practical means for caring for all edentulous persons.

SUMMARY

In my discussion of the unfavorable prosthodontic aspects of implant dentures, I have avoided reference to the surgical techniques and consequences which are being discussed by others. I have only touched upon what I believe to be disadvantages or deficiencies of the procedures.

The most serious disadvantage is that the procedure cannot be used for those who need it most. It is not advised for aged, infirm, or unhealthy people. Soft tissue–borne dentures can be and are made for these people, and if they are carefully and precisely constructed, these dentures do provide teeth which are comfortable and usable.

Judging by the implant dentures I have seen and by many illustrations in books and periodicals, insufficient attention has been paid to jaw relations and occlusion. These are phases of construction techniques that could be corrected easily, however, if more attention was paid to them.

The illustrations I have seen of upper implant dentures indicate that too little consideration has been given to phonetics.

The shape of the maxillae and mandible is altered by resorption. This resorption may occur under soft tissue–borne dentures and implant dentures alike. It is more disastrous when it occurs under implant dentures.

The expense of treatment of edentulous patients by implant dentures makes the procedure unavailable to many people who might be benefited by it.

The time involved in treatment of edentulous patients by implant dentures makes the procedure unavailable to most edentulous patients because there are not enough dentists to provide the service, even if all other unfavorable considerations were eliminated.

This discussion is not intended to discourage sincere workers from further experimentation in this field of prosthodontics. Instead, I hope that it may point the way to an improvement of implant denture service.

REFERENCES

1. Gershkoff, A., and Goldberg, N. I.: Implant Dentures, Philadelphia, 1959, J. B. Lippincott Co., pp. 73 and 74.
2. Atwood, D. A.: A Cephalometric Study of the Clinical Rest Position of the Mandible. I. The Variability of the Clinical Rest Position Following the Removal of Occlusal Contacts, J. Pros. Den. **6**:504-509, 1956.

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MISCELLANEOUS

FUNCTIONAL ANALYSIS OF HUMAN MANDIBULAR GROWTH

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SCIENTIFIC STUDY OF MANDIBULAR GROWTH began in the eighteenth century with the investigations of Hunter and DuHammel. They used techniques of metallic implants and vital staining which are currently in vogue. A tabular summary of the results of these classic methods is shown in Table I.

GENERAL PATTERN OF MANDIBULAR GROWTH

The general pattern of human mandibular growth has been established.

Chin.—At birth, there is no mental prominence (chin). The chin develops postnatally by external surface apposition during the first few years.

Mandibular Body (Corpus) Length.—At birth, the mandibular body is long enough to accommodate the complete deciduous dentition. Eruption of the permanent dentition is correlated with an anteroposterior increase in mandibular body length. This, in turn, is related to a posterior movement of the ramus.

Mandibular Body Height.—Relatively little apposition occurs at the lower border of the mandible. In comparison, the growth of the alveolar process is great accompanying the eruption of the permanent teeth.

Ramus Height.—Increases in ramus height are reflected chiefly by the processes of endochondral ossification which occur in the condylar cartilage. Minor alterations occur in the gonial region at the attachments of the masseter and internal pterygoid muscles. Increase in coronoid process height is similarly complementary to increased temporal muscle size. There is an intercorrelation between growth of the coronoid and condyloid processes themselves.

Ramus Width.—During childhood, the entire ramus increases in width while it is *simultaneously* being relocated posteriorly in space. This entails resorption of the anterior ramal surfaces and apposition at the posterior surfaces. Obviously, for an increase in total ramus width to occur, the rates of apposition must exceed those

Presented in part to the American Denture Society, New York, N. Y.
Supported in part by Grant B-965, C-3, National Institutes of Health, U. S. Public Health Service.
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TABLE I. BRIEF HISTORICAL REVIEW OF STUDIES OF POSTNATAL MANDIBULAR GROWTH

INVESTIGATOR AND DATE	METHOD	TYPE OF STUDY	ANIMAL	NUMBER	AGE	FINDINGS
Hunter, 1778	Madder feeding	Longitudinal	Pig	2	?	1. Increase in size by apposition at posterior border of ramus
	Osteometry	Cross sectional	Human	4	5 yr. to adult	2. Remodeling of jaw by resorption of anterior border of ramus 3. Increase of condyloid and coronoid processes above the line of the teeth 4. Increase in height of body, because of alveolar growth
Humphry, 1871	Implantation of wires into ramus	Longitudinal	Pig	?	?	Confirmed Hunter's findings
Keith and Campion, 1922	Osteometry	Cross sectional	Human (skulls)	2	5 and 25 yr.	Confirmed Hunter's findings
Brash, 1924	Madder feeding	Longitudinal	Pig	?	20 to 26 wk.	Confirmed Hunter's findings
Brodie, 1941	Serial roentgenograms	Longitudinal	Human	21	3 mo. to 8 yr.	1. Condyle contributed to increase in height of ramus and forward growth of mandible 2. Mandibular angle remained stable 3. Angular relation between lower border of mandible and cranial base established by third month of life

Hulen, 1948	Metallic implants combined with serial roentgenograms	Longitudinal	Dog	4	?	1. No new findings 2. Primarily description of method
J. H. Scott, 1951	Roentgenograms	Cross sectional	Pig	3	2 wk., 3 mo., 8 mo.	1. Little resorption of bone at anterior border of ramus 2. Little or no growth at inferior border
Baume and Becks, 1953	Histologic	Cross sectional	Rhesus monkey	20	?	Growth of bone at anterior and inferior borders of mandible
Robinson and Sarnat, 1955	Metallic implants combined with serial roentgenograms	Longitudinal	Pig	9	8 to 20 wk.	1. Same as Hunter, Keith and Campion, and Baume and Becks, but stable base was obtained in mandible so that serial pattern of growth was accurately obtained 2. The mandibular canal increased in diameter, and its relative position changed as height of the mandibular body increased with age
Bjork, 1955	Metallic implants	Longitudinal	Man	5	4 to 15 yr.	1. Described method 2. Showed great individual variability in mandibular growth

This table was derived from that of Robinson, I. B., and Sarnat, B. G., Am. J. Anat. 96:37-64, 1955, and extended.

of resorption. This posterior ramal shift, as well as the increase in ramus height, is once more functionally correlated with the eruption of the permanent dentition and therefore also coincident to the increase in alveolar process height.

This is not the complete story. For one thing, these descriptions are relatively static. They do not consider the functional matrix within which the mandible exists. Second, the role of the condylar cartilage is left open to question. It has been incorrectly assumed far too long that the proliferation of the condylar cartilage produces an upward "growth force" against the mandibular fossa which results in a reactive downward and forward motion of the entire mandible. Indeed, this naive and primitive concept has been held to account totally for *both* the growth and the forward movement of the mandible with age. It shall be demonstrated that such a concept is scientifically untenable and, further, that the growth of the condylar cartilage is actually a compensatory event, the *result* of mandibular movement and not its *cause*.

MANDIBULAR MATRIX

Mandibular structure is meaningful only in terms of its functions. All function occurs within a matrix of related soft tissues, i.e., within a functional matrix. The mandibular matrix consists, in part, of (1) all muscles with mandibular attachment, (2) neurovascular triads (arteries, veins, and nerves), (3) associated salivary glands, (4) the teeth, (5) fat, skin, and connective tissues, (6) the tongue, and (7) the oral and pharyngeal cavities. The mandible is situated and it grows and functions within this matrix. The structure of the mandible reflects this fact (Fig. 1).

Experimental data make it clear that removal or denervation of the temporal muscles produces atrophy or disappearance of the coronoid process.[1] Similar pro-

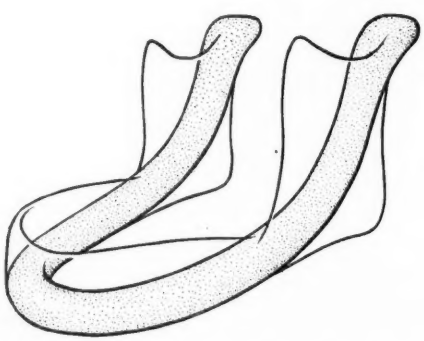

Fig. 1.—A functional analysis of mandibular form. The tissue related to the teeth, the temporal muscle, and the masseter-pterygoid muscle sling are clearly delineated from the stippled basal bone. (After Symons, N. B. B.: D. Rec. 71:41-53, 1951).

cedures with the gonial sling muscles (masseter and internal pterygoid muscles) alter mandibular angle arrangement,[2] and it is a clinical commonplace that alveolar bone loss may be total in the edentulous patient. Therefore, these tissues are functionally related to specific portions of the functional matrix within which they exist.

While the *formation* of these bony areas is undoubtedly intrinsically *(genetically)* determined their *maintenance* is related to extrinsic (environmental and functional) factors.

Further consideration of this matrix hypothesis is essential. It follows that if a bone exists within such a matrix and if its structure reflects the functioning of this matrix, the growth of this bone and its changing position in space are related to the growth of the matrix. Simply put, the mandible grows as its matrix grows. No one would seriously argue that growth of the mandible *causes* the growth of the tongue. However, all would agree that these events are somehow correlated. Evidence shall be presented that the growth of the functional mandibular matrix is probably the primary event which causes the relocation of the mandible in space and that the increments of condylar length are but secondary, compensatory events.

NEW CONCEPTS OF MANDIBULAR GROWTH

Three phenomena occur during mandibular growth which shed light on these problems.

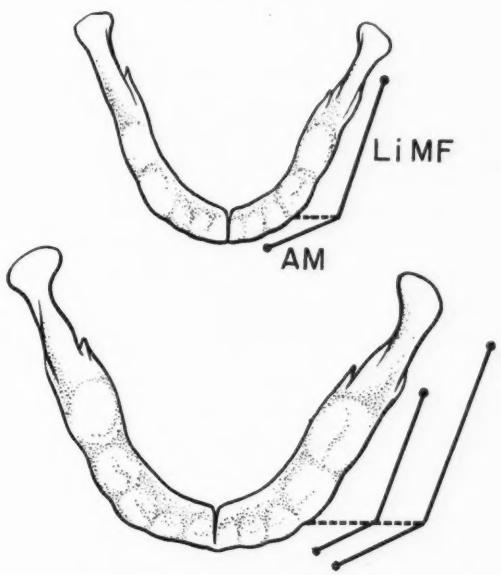

Fig. 2.—Fetal and newborn human mandibles. The dimensional increases in the premental *(AM)* and postmental *(LiMF)* foraminal segments are constantly proportional. An identical relative relationship holds for all postnatal stages of mandibular growth. (From Moss, M. L.: Disorders of the Temporomandibular Joint, Philadelphia, 1959, W. B. Saunders Company, ch. 6.)

Constancy of the Relative Position of the Mental Foramen in the Mandibular Corpus.—If the horizontal mandibular body is divided into premental and postmental foraminal segments (Fig. 2) and these segments are measured at all ages, it is found that the lengths of these two segments remain relatively proportional

TABLE II. POSITION OF MENTAL FORAMEN RELATIVE TO MANDIBULAR DENTITION, BY PERCENTAGE, LEFT SIDE, AMERICAN INDIANS

STATUS	C	m_1 (P_1)	m_1-m_2 (P_1-P_2)	m_2 (P_2)	P_2-M_1	M_1
No deciduous dentition (N = 14)	71.5	28.5				
Lower deciduous incisors erupted (N = 14)		100.0				
Deciduous second molars not erupted (N = 9)		100.0				
Complete deciduous dentition erupted (N = 65)		90.8	9.2			
Permanent first molars erupted (N = 29)		38.0	44.8	17.2		
Permanent first molars and first and second incisors erupted (N = 36)		16.7	44.5	38.8		
Permanent second molars erupted (N = 23)			39.1	60.9		
Permanent third molars erupted (N = 43)			7.0	57.8	25.5	11.7

After Moss, M. L., and Greenberg, S. N.: Angle Orthodont. 29:169-176, 1959.

throughout life.[3] Since this is so, increase in corpus length cannot be due solely to condylar growth, since this would only serve to constantly increase the relative size of the post mental foraminal segment. The entire mandibular corpus expands in space to accommodate for the growth of the oral cavity and tongue, among other things. This is accomplished chiefly by ectofacial apposition and endofacial resorption. Such a process simultaneously increases the length of both corpal segments and translates the mandible outward in space (Fig. 2). The rate at which these events occur is not constant. Spurts are noticed which correspond to the eruption of the permanent dentition and to the generalized preadolescent period of growth acceleration.[4,5]

Absolute Migration of the Dentition Through the Alveolar Bone.—This movement, which is quite apart from "mesial drift," occurs during the first two decades. While the position of the mental foramen remains relatively constant, the relation-

TABLE III. THE POSITION OF THE MENTAL FORAMEN RELATIVE TO MANDIBULAR TEETH, BY PERCENTAGE

SAMPLE AND AUTHOR	P_1	P_1-P_2	P_2	P_2-M_1	M_1	NUMBER
Brazilian adults (della Serra)[18]	0.5	33.0	58.5	6.5	2.0	100
Unselected adults (Tebo)[19]	1.8	23.0	49.9	24.1	1.2	100
Random adult sample from the American Museum of Natural History (Moss)	0.6	27.1	50.8	19.3	2.2	184
Australian aboriginal adult mandibles from the same institution (Moss)				100.0		31

After Moss, M. L., and Greenberg, S. N.: Angle Orthodont. 29:169-176, 1959.

ship of the mandibular dentition to it does not. The pertinent data are shown in Table II. This mesial migration is both a generalized primate pattern[6] and a generalized mammalian pattern.[7] The motion is most pronounced at the eruption of the permanent dentition and continues to a degree that is, seemingly, racially determined (Table III).

Change in Direction of the Mental Foramen.—This foramen may be properly likened to the nutrient foramen of any long bone. When a pin is placed in such a foramen, the anatomist says that the protruding head of the pin "points to the more rapidly growing end." Fig. 3 shows that in the newborn such a pin in the mental foramen points forward, while its direction is upward at 6 years and relatively backward in the adult. The explanation for such behavior and for the behavior of any long bone nutrient foramen has been concisely given by LaCroix.[8] It is claimed that the periosteum of a growing bone is under tension and that the tensile forces at a given point are proportional to the growth rates of the two ends of the bone

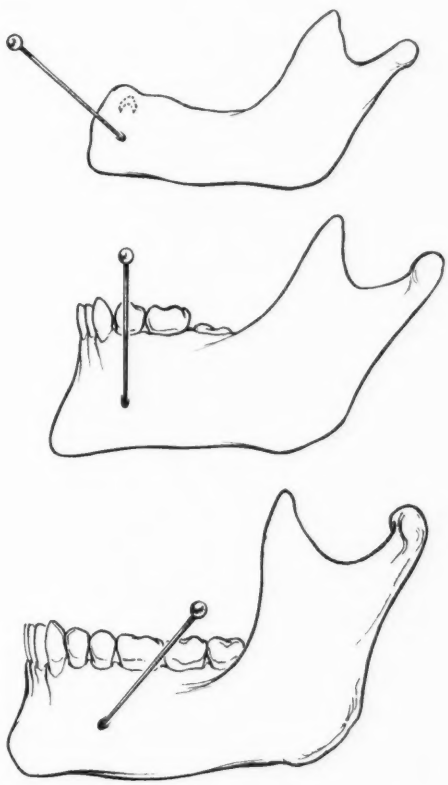

Fig. 3.—Newborn, 5-year-old, and adult mandibles. A pin is placed in the mental foramen. Note the shift of the relative position of the teeth to the foramen and the change in direction of the head of the pin. The pin points in the direction of the greatest bone growth. At birth, the chin is being formed; at 5 years, the alveolar height is increasing; in the adult, there is the increase in body length to accommodate the molar series. (After Schuricht, H.: Über Veränderung am Unterkeifer während der ontogenetischen und phylogenetischen Entwicklung, Halle, 1952, Max Niemeyer.)

Fig. 4.—Sliding of the periosteum, indicated by the arrow, causes displacement of the nutrient canal (mental foramen). The continuous lines show the canal in its present form. Dotted lines show the canal at an earlier stage. The arrow also indicates the site at which the most rapid bone growth is occurring. (After LaCroix, P.: The Organization of Bones, Philadelphia, 1951, Blakiston Company.)

(Fig. 4). When the growth rate of one end predominates, the periosteal tension in that direction will be greater. The effect of such unequal tension is "slipping" of the periosteum and consequent migration of the point of entry of the nutrient vessels. This, together with the surface apposition of new bone which accompanies growth in width, causes the foramen to face in the direction of the most rapid growth.

In the newborn, the formation of the chin is the most rapid mandibular growth process, and accordingly the foramen faces forward. With the first eruption of the permanent teeth, the increase in corpus height produced by alveolar growth assumes this role and the foramen faces upward. Subsequent additions to corpus length and the posterior shift of the ramus, which occur with the eruption of the permanent second and third molars, direct the foramen backward.

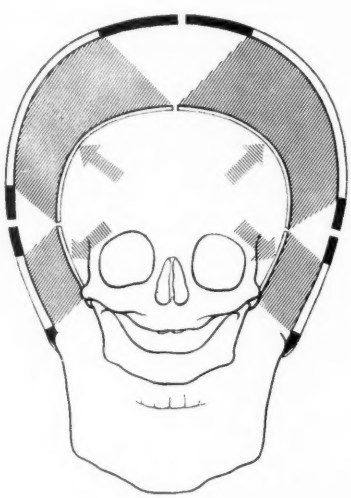

Fig. 5.—Lateral expansion of the neurocranium. The direction and amount of growth are not quantitatively accurate. With the expansion of the brain, the neurocranial capsule is carried outward. Without concurrent growth at the sutural edges, these bones would become widely separated while being passively transferred to their new position. Addition of bone at the sutures, shown in black, is a compensatory growth process necessary to keep the bones in close approximation. (From Moss, M. L.: Disorders of the Temporomandibular Joint, Philadelphia, 1959, W. B. Saunders Company, ch. 6.)

These additional phenomena of mandibular growth, when added to the firmly established classic data, present a more dynamic concept. The mandible is not simply growing. It is not just adding to its length and height and so passively carrying the teeth downward and forward. Certain other events occur simultaneously. The part of greatest growth rate is shifting, the entire dentition is migrating mesially, and the mental foramen is retaining a relatively constant position while it alters its direction of opening. *None* of these later events are in any way even theoretically dependent on growth at the mandibular condyle.

COMPENSATORY GROWTH OF THE CONDYLE

The mandible exists within a functional matrix. Similarly, the calvarial bones of the skull vault exist within a matrix that consists of the brain, meninges, cerebrospinal fluid, and scalp. The mode of growth of the skull vault is clearly analogous to the present problem.

The calvarial bones exist within a mass of soft tissues known as the neurocranial capsule.[9,10] In a sense, these bones are only the ossified portion of the capsule, while the dura mater and the sutural tissues are the unossified portions. This capsule, as a whole, expands in response to the growth of the enclosed soft tissue brain mass. If the mass is abnormally small (microcephaly) or if it is abnormally large (macrocephaly), the neurocranial capsule is correspondingly small or large. Indeed, it is not necessary for the brain itself to be present so long as an equivalent fluid mass continues to similarly increase in size, as in hydrancephaly.[11] In any event, as the neural mass expands, the capsule expands. As a result, the calvarial bones, which are embedded *within* the capsule, are *passively* carried outward (Fig. 5). Such spatial translation would obviously increase sutural width. Since sutures yield certain mechanical advantages to the skull,[12] it behooves the vault to maintain normal sutural dimensions. The vault does so by *secondary, compensatory* formation of bone *at* the sutural edges of the opposing bones. Despite all previous claims, *in no way* do the sutures act as epiphyseal plates. Whatever else a suture does, proliferation of its connective tissue elements does *not* generate an expansive force which pushes the bones apart.[12,13]

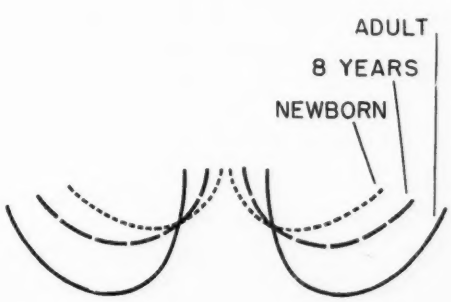

Fig. 6.—A diagrammatic coronal section at the sella turcica shows the growth of the human middle cerebral fossa The simultaneous downward growth and lateral expansion are illustrated. (After Dabelow, A.: Morphol. Jahrb. 67:84-133, 1931.)

The growth of the neural mass is the *primary* event in calvarial growth. The growth of the bones is secondary and compensatory to this phenomenon. So it is with the mandible. This bone also exists within a sort of capsule formed by the soft tissues of the face. Analogously, the expansion of the functionally related viscera (the tongue, muscles, teeth, oral and pharyngeal cavities, salivary glands, etc.) is the *primary* event in condylar growth. The proliferation of the condylar cartilage and its subsequent endochondral ossification are as much *secondary, compensatory* events as was the addition of bone at the calvarial suture edges. The growth of the facial viscera is by itself primarily sufficient to translate the entire mandible in space. As a consequence, the temporomandibular articulation would be lost as the condyle became disengaged. It is to preserve this functionally important joint that secondary cartilaginous growth occurs in the condyle.

DATA SUPPORTING HYPOTHESIS OF CONDYLAR GROWTH

Four sources of data, among others, may be adduced to support this hypothesis. First, a considerable lowering of the mandible occurs as a direct result of the growth of the brain. Generalized cerebral expansion, specifically the volumetric increase of the temporal lobes, is accompanied by increases in both the horizontal and vertical dimensions of the middle cerebral fossa. Such vertical increases, in themselves, are sufficient to lower the position of the temporomandibular joint without any need for direct participation by the mandible (Fig. 6).[14]

Second, the condyle was either unilaterally or bilaterally removed in growing animals.[15] The data conclusively demonstrate that while the vertical growth of the *ramus* was seriously interfered with, the growth of the mandibular corpus was unaffected and, furthermore, the spatial position of the corpus was normal.

A third source of evidence has been provided by the statistical techniques of Cleaver,[16] applied to anthropometric mandibular data. It was established again that the dimensions of the ramus were uncorrelated with those of the corpus. The conclusion was drawn that the growth of these two portions of the bone was similarly independent.

Finally, there is the natural experiment of congenital bilateral absence of the rami.[17] Here the mandibular body and the teeth are in good spatial relationship to the normal maxillae. Obviously, without condyles, interstitial expansion of a cartilaginous epiphyseal-like plate can have played *no* role in either the growth of the corpus or its spatial location. Such isolated mandibular bodies can only have grown and moved as a response to the primary growth and movement of their functionally related viscera.

TREATMENT FOR ANKYLOSIS

Parenthetically, it follows from these concepts that a correct treatment for ankylosis of either or both of the mandibular condyles would be the removal of the affected condyles. Such a treatment, while obviously diminishing potential ramal dimensions, would permit the mandibular body to move in space in response to the normal growth of the facial viscera. Obviously also, such treatment must occur early. Delay can lead only to increased deformation and functional embarrassment.

REFERENCES

1. Washburn, S. L.: The Relation of the Temporal Muscle to the Form of the Skull, Anat. Rec. **99**:239-247, 1947.
2. Rogers, W. M.: The Influence of Asymmetry of the Muscles of Mastication Upon the Bones of the Face, Anat. Rec. **131**:617-632, 1958.
3. Moss, M. L.: Differential Growth Analysis of Bone Morphology, Am. J. Phys. Anthropol. **12**:71-75, 1954.
4. Tanner, J. M.: Growth at Adolescence, Springfield, Ill., 1955, Charles C Thomas, Publisher.
5. Nanda, R. S.: Cephalometric Study of the Human Face From Serial Roentgenograms, Ergebn. Anat. u. Entwicklungsgesch. **35**:358-419, 1956.
6. Moss, M. L., and Greenberg, S. N.: Developmental Migration of Mandibular Buccal Dentition in Man, Angle Orthodont. **29**:169-176, 1959.
7. Brash, J. C.: Comparative Anatomy of Tooth Movement During Growth of the Jaws, Tr. Brit. Soc. Study Orthodont., 1952, pp. 97-118.
8. LaCroix, P.: The Organization of Bones, Philadelphia, 1951, Blakiston Company.
9. Moss, M. L.: The Pathogenesis of Artificial Cranial Deformation, Am. J. Phys. Anthropol. **16**:269-286, 1958.
10. Moss, M. L.: The Pathogenesis of Premature Cranial Synostosis in Man, Acta anat. **37**:351-370, 1959.
11. Minckler, J., McCurdy, T., and Iverson, J. C.: Hydranencephalus With Cerebellar Hemidysgenesis, Nebraska M. J. **26**:131-135, 1941.
12. Moss, M. L. Growth of the Calvaria in the Rat, Am. J. Anat. **94**:333-362, 1954.
13. Pritchard, J. J.: Experimental Alteration of Cranial Suture Pattern, J. Anat. **90**:573, 1956.
14. Dabelow, A. Über Korrelationen in der phylogenetischen Entwicklung der Schädelform, Morphol. Jahrb. **67**:84-133, 1931.
15. Sarnat, B. G., and Engle, M. B.: A Serial Study of the Mandibular Growth After Removal of the Condyle in the Macaca Rhesus Monkey, Plast. & Reconstruct. Surg. **7**:364-388, 1951.
16. Cleaver, F. H.: A Contribution to the Biometric Study of the Human Mandible. Biometrika **29**:80-112, 1937.
17. Kazanjian, V. H. Bilateral Absence of the Ascending Rami of the Mandible, Brit. J. Plast. Surg. **9**:77-82, 1956.
18. della Serra, O.: Topografia do canal mandibular, São Paulo, 1945, pp. 1-114.
19. Tebo, H. G.: Variations in Position of the Mental Foramen, D. Items Interest **73**:52-53, 1951.

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WRITING—THE INTELLECTUAL MICROSCOPE

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YOU ARE WATCHING A DENTIST of good reputation at work in a clinic. He is preparing a cavity. He picks up an air rotor handpiece, puts in a large fissure bur, and starts cutting without turning on the water coolant.

You know what that bur—running 150,000 revolutions or more per minute—does to the tooth. It kills or severely damages the pulp. Naturally, you are surprised that a man of such good reputation does not know the right size of bur to use or the proper way to keep a tooth cool while operating this high speed drill.

Frankly, I have been just as surprised to watch professional men who have distinguished reputations walk into the writing clinic, pick up instruments they have not been properly trained to use, and go to work with apparent confidence that the results will be satisfactory.

Despite their ability or even brilliance in their own fields, they have failed to see that writing is a complex intellectual discipline which can be learned only through precise study and careful practice.

Although most of my remarks will be directed toward dentistry and medicine, the writing problem is not peculiar to these fields. It is just as widespread and acute in education, engineering, law, and other professions, as well as in business and industry.

Dentistry has a definite advantage over some of the other professions: it is very aware of the problem and is determined to come to grips with it. This was clear even before we began at Ohio State University in January, 1958, our special series of courses in scientific writing for dentists and physicians. And it was confirmed as I lectured at other colleges of dentistry.

Whereas men in other professions were complacent and hard to dislodge from old thinking about communications, dentists obviously were searching for ways to improve. As we planned our courses, three men were especially helpful and outspoken in their comments about dental writing. Two were editors of dental journals; the third directed the graduate training program in the college of dentistry at a midwestern university.

They said quite frankly that poor communications had blunted prime tools of dental education. They criticized ineffective writing in journals. They said something should be done about complexly written, verbose textbooks. They reported that far too many papers presented at dental meetings were dull and offered

Presented at the Conference of Dental Graduate Training Program Directors for the National Institutes of Health at Western Reserve University, Cleveland, Ohio.
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little that was new. They declared that some classroom lectures were poorly organized, ineptly presented, meandering, and sleep producing; others were barren because the professors talked over the students' heads. It all added up to one thing: a roadblock in the progress of patient care.

This was no surprise to us as teachers and students of writing. We had seen roadblocks in communications slow the advance of other professions. The pattern was classic. Complex writing kept valuable information from reaching those who needed it; the reader could not or would not hack his way through a jungle of language.

We moved ahead cautiously in our search for ways to make dental writing more effective. The teacher of writing usually finds himself enmeshed in both psychologic and educational problems. Writing is a highly personalized thing, a bit of the person who produces it. And it is seldom born without anguish.

Yet the effective writing teacher must sit shoulder to shoulder with an author and analyze his work, pointing out his strengths and his weaknesses in both language and content. In the early stages this is a painful experience, particularly for the writer. To him every word in his manuscript is vital, every phrase deathless, every thought profound. The teacher who criticizes runs about the same risks as he would in finding fault with a new mother's first-born.

The writing teacher—whether he is a dentist or journalist—must be as thorough in his analysis as the dental or medical diagnostician. He must be both humble and bold. He must respect the traditions of the profession; but he must not give in to needless taboos or be coerced by the tired old statement that "this is the way dentists have always written."

The answer to that archaic argument is clear. Dentistry has progressed swiftly in recent years because dedicated men have questioned and retested nearly every theory, every postulate, every hypothesis, every technique and method. The good have survived; the inadequate have been replaced. Now the time has come to question dentistry's communication techniques. The effective should be kept; the ineffective should be abandoned.

This is also true of methods used in teaching writing. If the training in writing the student receives before he enters dentistry is inadequate—as it all too obviously is in most cases—the job must be done in the colleges of dentistry. If the old techniques for teaching writing have failed, new ones should be developed.

Many questions should be asked: How do you motivate a student or faculty member to write—not only to make him write but to make him *want* to write? At what level should courses in professional writing enter the dental curriculum? Should they be offered to all students or only to those doing graduate work? (This is costly teaching that can be done well only in small groups. It takes 2 years or more to teach a talented dentist with an interest in communication to become an effective instructor of professional writing.)

WRITING IS A RESEARCH TOOL

We do not know the answers to these and many other key questions about dental writing and the teaching of dental writing. We are seeking the answers,

however, in our experimental teaching and our research into dental writing. We are pleased to report that our studies are sponsored by the National Institutes of Health. We are making progress in this work and we have learned some interesting facts that emphasize the importance of training in scientific writing:

1. Scientific writing is a basic research tool.
2. Training in scientific writing saves valuable professional time.
3. Training in scientific writing produces more and better papers.
4. Training in scientific writing means better dental education.
5. Training in scientific writing improves patient care.

For the past 2½ years a candidate for the Master's Degree in Dentistry at Ohio State University has had two advisers—one in his own college to approve the content, the other in journalism to approve the language of his thesis.

We use a teaching teamwork approach. Under the supervision of his dental adviser, the student develops his research plan of action, gets it approved, then goes into the laboratory.

Meanwhile, he enrolls in our courses in dental writing. Here he learns to dig deeply into the statements of his sources as he prepares his literature review. He learns both to *respect* and *distrust* what he reads. He discovers that a man may be right about one thing and wrong about another; that he may think thoroughly on one occasion and incompletely upon another.

He learns to watch for the danger signals: complex language, obscure language, circuitous language, verbosity, pomposity, dogmatism, improper selectivity, and evasion of responsibility for an idea or statement. Any of these can hide confused thinking, incomplete or inaccurate research, an erroneous approach, the weighting of an argument, or the slanting of information.

He comes to appreciate the author who will speak out crisply, who will leave no doubt in the reader's mind about what he means, and who will take full responsibility for his statements. He respects such an author's honesty and forthright approach, even when disagreeing with his opinions.

He soon recognizes the author who has little to say, who is writing just to get into print or to impress his readers, rather than express an idea. Such an author's trademark is pomposity. He has the mistaken belief that big words are the sign of a big man with big thoughts.

In searching the literature, our students also are taught to look for the crime by omission. Some authors deliberately or inadvertently avoid one or more aspects of a controversial subject. This kind of selection may make it easier to prove a point, but a weighted argument is not very scientific. The answer, of course, is a complete review of the literature.

Controversy is stimulating. An author has a right to take any point of view he wishes and to support it. But he also has a responsibility to balance his stand with a fair report of the other side of the question. Slanted reporting is common on the political scene, but responsible editors condemn it. Certainly, in science there is no place for the twisting of information or the ignoring of facts.

While the student is taught to be suspicious, cautious, and critical in his library research—traits that also serve him well in the laboratory—he tries to be completely objective in his approach.

He realizes that some truths must be stated more profoundly than others, and that not all authors who write complexly are subject to suspicion. Many, including some men our students work with every day, have been forced to learn to write by the painful process of trial and error. Through no fault of their own, they have never had an opportunity to dig deeply into the problems and techniques of writing. From their predental days on, they have been too busy mastering the growing mountain of technical and scientific data in dentistry and related fields.

Through a study of writing the student discovers—perhaps for the first time—that there is no inflexible relation between the intellectual level of an idea and the grade level at which it is written. One of the proofs of intellectual power is the ability to distill an idea until it is reduced to a crystal clear simplicity that can be expressed in crystal clear language. In the words of the philosopher-mathematician Bertrand Russell, ". . . Find the shortest way to say something without ambiguity."[1]

The student studies examples which prove that even the most complex ideas can be expressed in relatively simple language. It takes work, but it can be done; for Albert Einstein often wrote at eighth grade level, Bertrand Russell at ninth grade, and Henry David Thoreau, the philosopher-naturalist, at tenth grade, to cite just a few of the examples used in our classes.

Why did such great thinkers write simply? They knew that effective writing must be approached from the point of view of the reader. The idea burden that a reader can carry must come by the cupful or bucketful, not in tank trucks. A writer who writes complexly page after page usually exhausts the reader, then loses him, even if the reader's IQ level is high and his educational background is extensive.

Learning all this helped our students, but it was when they sat down to write about their own research work that we made our most important discovery. Writing, we realized for the first time, is a basic research tool. *It is an intellectual microscope that brings into focus both research facts and the meaning of those facts.*

Dr. William Lefkowitz* and I stumbled across this when we asked ourselves why—despite most careful safeguards—students found holes in their research and thinking when they began to write about that research and thinking.

The students had outlined their research plans carefully with the help of their advisers; they had discussed these plans thoroughly. In the laboratory they had taken detailed notes; they had examined their progress (or lack of it) step by step with their advisers; they had checked and rechecked to make certain their research was on the mark and as complete as the limitations of the project would permit.

Yet when they began to put on paper, in complete sentences, full information about their research and when they began to interpret in detail what they had found, something new was added that was not apparent in their notes. It was as though they had put their work on a slide and focused it under a microscope. Now

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*Professor Lefkowitz (D.D.S.) now heads graduate research at the University of Kansas City, School of Dentistry.

they saw it whole for the first time, with all the facts in their proper relationship and with their proper shading and highlights.

This was more than a matter of cloudy writing which could be corrected in minutes by careful editing. It went beyond shrouded thinking that could be cleared up by re-examining the facts and rewriting. It was basic. It pointed toward the heart of the research process. Our colleague, Dr. Carl O. Boucher,* put it this way:

"One of the problems in dental progress is that both in the clinic and the laboratory we do not really see what we are looking at. Precise, complete writing makes us see some facts and their significance clearly for the first time."

Dr. Rudy C. Melfi† provided an example last year in writing his thesis, "The Dentino-Pulpal Membrane." He was seeking to determine the source of the odontoblastic process. Was it related to any one odontoblastic cell?

In trying to describe, in writing, what appeared on his histologic serial sections, he saw something he had overlooked before—that the odontoblastic process did not reach to the dentinoenamel junction. Previous thinking was that the process joined the dentinoenamel junction. Here was evidence that it receded in adults.

Dr. Melfi realized that, from a clinical standpoint, this was more important than the original purpose of his thesis. If he could show that the process actually did recede in adults, cutting below the dentinoenamel junction in an ordinary cavity preparation would *not* injure the pulp, as previously believed.

This was a significant development, one that both Dr. Melfi and Dr. Lefkowitz would have liked to follow up, but they recognized that they did not have enough sections to provide an adequate scientific basis for what they thought was something new. Besides, they were faced with the shortness of time that too often seems inevitable in thesis preparation.

Dr. Melfi wrote his thesis, detailing his research which showed that the odontoblastic process does not have its source from a single odontoblastic cell.

As he wrote he made another thorough search of the literature; he and Dr. Lefkowitz wanted to be certain that their finding about the odontoblastic process was really new. Dr. Melfi had nearly completed his thesis when he found a monograph by Dr. W. W. James[2]; it established, with adequate specimens, that in adults the odontoblastic process does recede from the dentinoenamel junction. After completing his thesis, Dr. Melfi gathered more specimens and confirmed Dr. James' work.

Dr. Melfi was so impressed by his experience that he made the bold suggestion that perhaps our approach to dental research should be reversed. He asked:

"Instead of searching the literature before or while you are doing a research project, why not do the research first and then search the literature? After all,

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†Melfi (D.D.S.) then was a graduate student and an NIH trainee in the College of Dentistry (1959). He now is an instructor in dentistry and an NIH postdoctoral fellow, working toward a Ph.D. in anatomy.

a project is supposed to be *original* research. Without our realizing it, what we find in the literature may not only color our thinking but also affect what we see. Instead of seeing what is really there, we may see what others have reported."

Dr. Melfi is using this laboratory research before literature review approach in working on his Ph.D. dissertation (on an embryologic study of the human jaw). He is limiting his literature study to standard textbooks, rather than going to journals and other such sources. When he finishes his laboratory work, he will complete his literature review. He also is doing something which we now recommend to all students. Instead of merely taking notes in the laboratory, he is writing out in full sentences, paragraphs, and pages what he sees, what he does, what he thinks. He feels this improves his effectiveness in his research; it certainly gives him a long head start in the writing of his dissertation. Does it slow down his work? He does not think so. On the contrary, it helps him think his work through more thoroughly and quickly.

Why are the thought processes more penetrating when facts and ideas are spread out in full sentences rather than in notes? We are not sure. But we do feel that somehow one full idea begets another full idea. And when you put flesh on the intellectual bones, the result can differ as much from the notes as a lovely girl's figure differs from a picture of her skeleton.

Less dramatic was the experience of one of our graduate students who was working on the effect of retraction materials on the epithelium of the gingival sulcus. As he was writing his thesis and interpreting his slides, he realized for the first time that his results were not reliable. The animal he had selected already had a number of the conditions present in gingivitis: stripping, inflammation, hydropic degeneration of the cells—all among the criteria he had set up to evaluate damage by retraction materials. Fortunately, he still had time to go back to the laboratory and start over with two new animals.

A mistake we caught at the writing stage (and probably should have discovered earlier) was in a study of bacteremia. The student used 10 ml. of blood for a control and 25 ml. for the experimental group. Quite an error, since you normally would expect to find more bacteria in a larger amount of blood, if bacteria were present.

GOOD WRITING SAVES TIME

Our second move in a new direction in our study of scientific writing was a preliminary attempt to determine whether effective writing can save sizable amounts of the reader's time and improve his comprehension of an article. We were not seeking precision but only a rough idea to help us decide whether this was a question we should study.

Two tests were conducted. One was by a journalism graduate student who worked with resident surgeons in the College of Medicine; the other was by Dr. William Lefkowitz, with senior dental students. Their methods were identical.

Forty residents were divided into two groups of 20 each. The groups were made as equal as possible on the basis of IQ and a cursory evaluation of their professional background and ability.

Each person in the first group of 20 residents was given a surgical paper written at the complexity level common in the *American Journal of Surgery.* (The level was 17, which means that except for technical language it could be understood by persons who had completed a year of graduate work in any field.)

A simplified version of the same paper, rewritten by the original author and containing all information found in the complex version, was given the second group of surgeons. (The complexity level was 12, which means that except for technical words it could be understood by persons with a high school education.)

All residents in both groups were asked to read their version of the paper until they were sure they could get a good grade on a comprehensive examination. When a surgeon said he was ready, his reading time was recorded; then he was given the examination and his comprehension score was determined.

We found that it took only 57 per cent as much time to read the simplified paper as it did the complex one. The comprehension scores on the complex paper averaged 77; on the simplified version the average was 93. The reading time was cut nearly in half, and comprehension was increased sharply. Dr. Lefkowitz had similar results in his test with 40 senior dental students.

There was one interesting sidelight. We asked 5 surgeons to read both versions of the medical paper and tell us which they felt was the more effective. The vote was unanimous for the simplified form.

We realize that much study needs to be done before this kind of test can have precise meaning. But the picture is clear to anyone who has tried to wade through a scientific journal (including those in dentistry) or has tried to untangle the meaning in a scientific textbook. The waste caused by confused, complex writing is huge. I present some figures, more to stagger your imagination than to make a point which I am sure has been clear to you for many years.

Throughout the world, more than 50,000 scientific and technical journals publish about 1,200,000 articles each year. Add to this 100,000 research reports and 60,000 new science books annually.[3]

Readers run in the millions; hours spent poring over the printed page must total in the billions. If improved writing could save not half, but only 10 to 25 per cent of the readers' time, think what this would mean! The time of the man of science is invaluable, irreplaceable.

Sir Mortimer Wheeler said it well in a report summarizing comments of Prof. R. O. Kapp, speaker at a meeting of the British Association for the Advancement of Science. The purpose of the meeting was to examine the problems involved in scientific writing:

". . . Talk and paper were among the more important of the tools with which the scientist and engineer had to work. Time was just as precious when reading a report as it was when using an instrument, and the worker could not afford to wait while a verbose author was developing an argument of unnecessary length. If one could justify training for research one could justify training in the art of exposition. Let scientists attempt deliberately and systematically to raise these standards of exposition in all its aspects, and try to perfect and teach it. Until this is done, science will continue to be hampered by the bad work of poor expositors."[4]

Wheeler quotes historian G. M. Trevelyan's comments about dull writing, showing that the problem has infected the humanities as well as the sciences:

"The idea that histories which are delightful to read must be the work of superficial temperaments, and that a crabbed style betokens a deep thinker or conscientious worker, is the reverse of the truth. What is easy to read has been difficult to write."[4]

An article that is not clear could be worse than useless or wasteful of time. It could cause actual damage if the person following its direction or suggestions made serious mistakes. The chance is remote but it is there. In dentistry, perhaps even more important than lost time or lost understanding are lost readers. Dentists are independent thinkers. They have made it clear that loose writers cannot trifle with their time or attention. They know good articles from bad, and they boycott the bad. This was shown in a survey conducted at the Dallas meeting of the American Dental Association.[5]

GOOD WRITING IMPROVES EDUCATION

The third thing that we have learned in our teaching and study is that training in scientific writing produces not only better papers but more papers. We have not kept an actual count; for quality, not quantity, is our interest. But the deans and department heads in both dentistry and medicine tell us that their men are writing more.

A kind of chain reaction has taken place. It began at the top. When we offered our courses in professional writing more than 2 years ago, many of our first students were faculty members—including department heads. Once they had taken the course, they became our most enthusiastic supporters. Students not only heard from us about the need to write and rewrite with precision until a paper sparkled, but they also heard about it from their own faculty advisers.

Most important of all from the point of view of the teacher was the reaction of graduate students and NIH trainees. At the Ohio State University they are an intellectually hard-nosed lot. Unless you know what you are talking about, you had better not take them on. They love a no holds barred discussion.

At first they were cynical. Their attitude was: "Who do these boys from the other side of the campus think they are, telling us how to write dental theses and articles?"

But they were as quick to approve as they were to question. Along about the third week they saw the real value of what we had to offer. After that they ran away with the course. By the end of a year they were working over each other's papers with vigor, and they all had become competent, confident writers. Writing had ceased to be a drudgery; it had become an opportunity. Even their conversation changed.

If one of them made a complex, stuffy comment, one of his colleagues rephrased it for him, much as a parent corrects a child's grammar; or he was told, "Come, come, old boy, put it in English." Once you seriously begin the study of language for one purpose, you find yourself studying nearly all language you see and hear.

In an atmosphere like this, writing begets research ideas and research produces more papers. Writing is a kind of intellectual catalyst that keeps the reaction going.

Those of us who teach have learned much from the students. We admitted to them at the outset that very little was known about how to teach professional writing quickly and well. We made it clear that this was an experimental course; that all the old ways and rules had to prove themselves or be thrown out. The students have responded so enthusiastically that at the end of every quarter I have a file drawer half filled with ideas and examples better than those I just have used. I have taught the beginning course three times, and I now am rewriting my notes for the third time.

A natural outgrowth of training in scientific writing is better dental education. When a way is found to teach all who prepare articles for dental journals to write effectively, the value of training in writing will be felt fully at the level of the practitioner. He will get the articles he wants and needs written in a clear, concise style. Better patient care will result on a wide scale because this important vehicle of dental education is doing a better job.

Meanwhile, progress is being made. Students who learn to write well and do library research well are bound to read better, think better, and learn more. We have seen progress, too, at the faculty level. Our highest compliment came from a complaining professor.

"You writers," he said during one of our classes. "Ever since I took your course I have been dissatisfied with my lectures. Now I am rewriting them all." A student in back of him whispered for everyone to hear, "It's about time!"

GOOD WRITING IMPROVES PATIENT CARE

The final suggestion I would like to make is that training in scientific writing already has helped improve patient care. This is the opinion of Dr. Robert M. Zollinger, Chairman of the Department of Surgery in the College of Medicine, and Dean Wendell D. Postle of the College of Dentistry. Dr. Zollinger made these points in a letter to the University administration, evaluating the science writing program:

Because they knew they would be expected to put every phase of their work on paper, the surgical residents learned to do many things better—to search the literature critically, to weigh all facts carefully, and to relate what they read and knew to their professional work. All this added up to more knowledge of medicine, and the patient benefited.

This opportunity to improve patient care through a better knowledge of scientific writing now includes only a limited number of professional people. But its value is so clear and the need so great that I am certain education in science writing will continue to grow.

In the years ahead we will probably solicit your help to make sure that this program continues to progress. For the hands of the dental writers of today and tomorrow will help shape the opinions that the profession and the public have of

dental research programs. After all, a dental paper should never be an end in itself. It should be an effective mirror of distinguished research and a powerful tool for better dental education and better dental health.

REFERENCES

1. Russell, B.: Portraits From Memory, New York, 1956, Simon & Schuster, p. 197.
2. James, W. W.: A Further Study of Dentine, Tr. Zool. Soc. London **29**:Monograph Part 1, 1957.
3. Holton, Gerald: Modern Science and the Intellectual Tradition, Science **131**:1187, 1960.
4. Wheeler, Sir M.: Archaeology From the Earth, London, 1954, Oxford University Press, pp. 186 and 187.
5. Survey of Dentists, Chicago, 1958, Publication Research Service.

305 West Twelfth Ave.
Columbus 10, Ohio

BETTER DUPLICATE TRANSPARENCIES

LORNE E. MACLACHLAN, D.D.S.
Ottawa, Ontario, Canada

COLOR PHOTOGRAPHY is playing an increasingly important part in clinic and lecture work and in patient education. Many of the professional man's transparencies used for these purposes are invaluable and often irreplaceable. It is of inestimable value to have duplicates of them. A simple do-it-yourself method will be described by which the original transparency can be not only duplicated but improved in the process without injury to the original. Photography is one field in which doing it yourself often yields better results than having someone else do it for you.

Anyone who has a camera with a 50 mm. lens (approximately) plus a 105 mm. or 135 mm. lens with extension bellows or extension tubes and an electronic flash can produce excellent duplicates with a little practice and patience. Many dentists already have some or all of the necessary equipment. It is a simple, not a difficult, procedure. It is merely a matter of photographing a color transparency. With an electronic flash assembly, roentgenograms and black and white transparencies can be duplicated in a single operation.

The camera is placed on a firm support. The transparency to be duplicated is firmly mounted between the camera and the electronic flash. The electronic flash makes it possible to have a constant light source (about 1/1,000 second) closely approximating daylight in quality. When floodlights are used for duplication, they lack proper color balance, heat the transparency, are subject to voltage changes, and deteriorate with use. The focusing light source is an electric light bulb (nonglare type) placed temporarily behind the transparency to be duplicated. Much can be done, during the process of focusing, to crop off any undesirable area away from the center of interest or around the borders of the picture. (Clear plastic lip or cheek retractors are desirable in making the original pictures, since they show the natural tissue color and do prevent the disturbing, brilliant reflections that come from metallic instruments.)

Compensation in the exposure must be made, because an extension tube or extension bellows increases the distance between the camera lens and the film and since the intensity of light varies inversely with the square of the distance. This is called "the exposure increase factor," and it is supplied with every close-up lens table. It appears on the track of the extension bellows.

CROPPING AND MAGNIFYING

Cropping a transparency magnifies the center of interest. This differs from straight duplication only in the length of the lens used (Figs. 1 and 2). The original

Read before the American Denture Society in New York, N. Y.

slide (Fig. 1) was mounted (as in Fig. 3) in a 2 inch by 2 inch opening in a ¼ inch plywood (flat black) mount approximately 8 inches wide and 12 inches high. The electronic flash was placed 12 inches from the back of the transparency. An Exakta camera with a 58 mm. lens on a Novoflex extension bellows was focused on the front of the transparency on the center of interest, which is the incisal edge of the two lower cuspids. The lens is approximately 2 inches from the slide.

To produce the amount of magnification obtained in the enlarged duplicate (Fig. 2), the exposure increase factor on the Novoflex scale was 7x. Stop f. 5.6 was used with Daylight Kodachrome film. Anscochrome and Ektachrome, ASA 32, would require a stop of between f. 8 and f. 11.

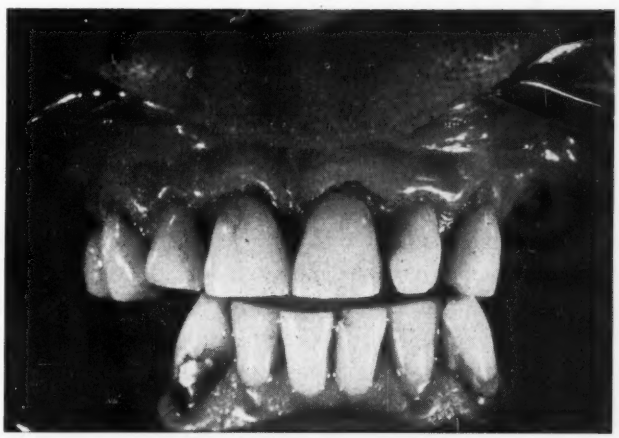

Fig. 1.—The original slide which is shown in position for duplicating in Fig. 3.

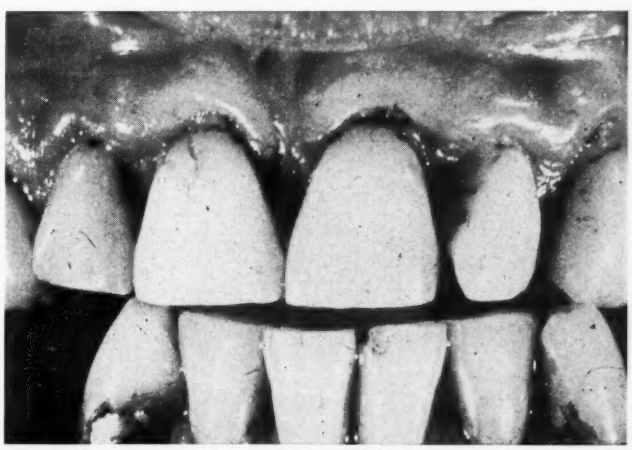

Fig. 2.—The duplicate of the original slide, cropped and enlarged to emphasize the center of interest.

EQUIPMENT

A Mighty Light Electronic Flash, an opal glass in frame, a transparency in position, an Exakta camera with a 58 mm. lens on a Novoflex extension bellows mounted on a tripod are shown in Fig. 3. This setup, with the addition of a nonglare electric light bulb (not shown), is used in focusing. At this point, the decisions are made as to the area of the transparency to be duplicated and whether it is to be cropped, reduced, or enlarged.

Fig. 4 shows the same equipment as in Fig. 3 with an opal glass hanging on the plywood mount between the transparency and the flash.

After the equipment is set up, a basic exposure is established. By use of a 58 mm. lens on a Novoflex extension bellows, I have found the data in Table I to be satisfactory guides.

In making a duplicate transparency the same size as the original, that is, 1:1, place the light 12 inches behind the transparency and make three test exposures. An electronic flash with a guide number of 60 to 70 for Daylight Anscochrome or Ektachrome film should give one correctly exposed duplicate among the three exposures at f. 11, f. 16, and f. 22. I use the Mighty Light DeLuxe Electronic Flash, which has for Daylight Kodachrome a guide number of 40 to 50 and for Anscochrome and Ektachrome, 65 to 80. If, for example, f. 16 gives the best duplicate of the same size, when focusing for double magnification use one stop larger and when focusing for one-half reduction use one stop smaller. If only duplicates of exactly the same size as the original are required, I suggest the use of the Medical-Dental Photo Company's new Slide Duplicator, otherwise known as The Copy Cat.

In duplication, *only* the electronic flash must illuminate the master slide at the moment of exposure; avoid light from any other source. Care must be taken also to avoid "bounce light" produced by the flash on the immediate surroundings.

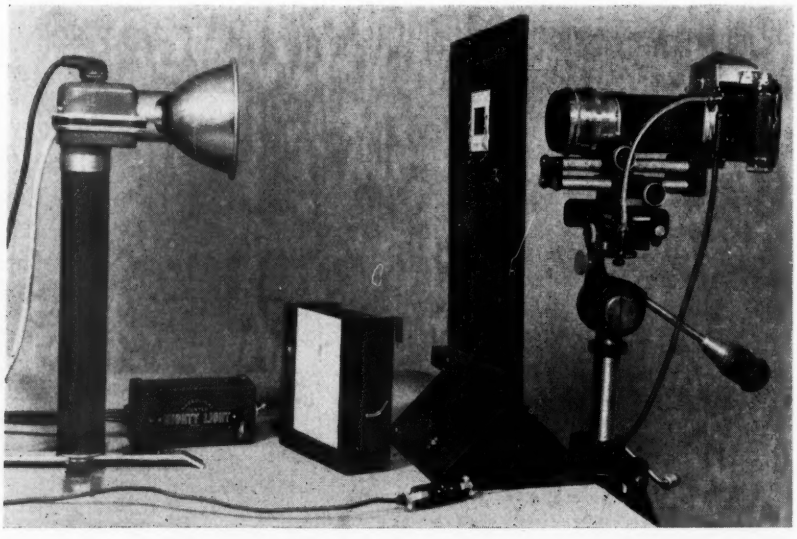

Fig. 3.—The equipment used for duplication, with the opal glass not in position.

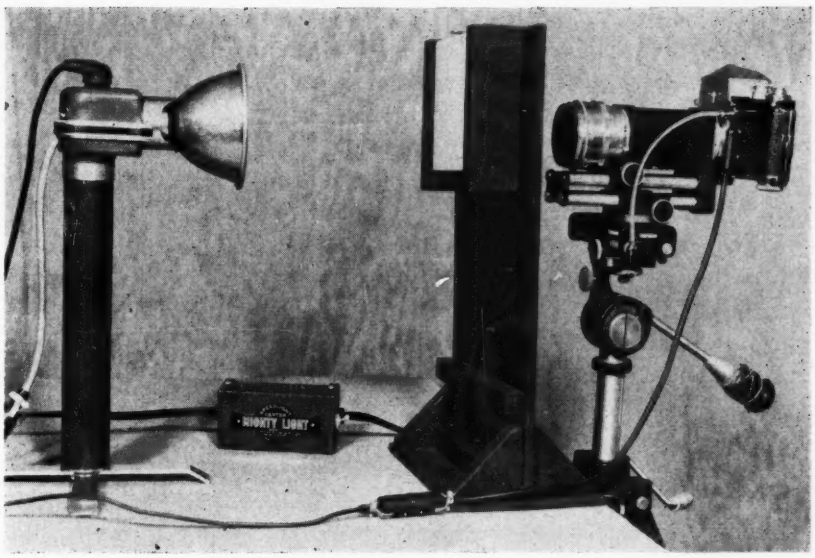

Fig. 4.—The equipment with the opal glass in position, ready for the exposure.

For example, a yellow room would produce yellow duplicates. Cover all the area between the flash and the slide with a cardboard carton painted flat black inside or with paper flat black in tone on the table and a large sheet of the same held over the flash-to-slide area. A successful enthusiast has found that an off-white (oyster shade) paper gave the best results for accurate color reproduction. Another interesting experiment produced seven different variations of color in duplicates by bouncing the light off seven different shades of paper.

CORRECTIONS

It is often very disappointing to find that a very important and irreplaceable original transparency has been either underexposed or overexposed. Either of

TABLE I. BASIC EXPOSURE

EXPOSURE FACTOR	APERTURE FOR KODACHROME DAYLIGHT FILM (ASA 10)	APERTURE FOR EKTACHROME OR ANSCOCHROME FILM (ASA 32)*
12x	f. 3.5	f. 5.6+
10x	f. 4	f. 5.6++
9x	f. 4.5	f. 8
7x	f. 5.6	f. 8++
6x	f. 8	f. 11++
5x	f. 8.5	f. 16+
4x	f. 11	f. 16++
3x	f. 11.5	f. 22+

* A single + equals approximately one-third of a stop; ++, approximately two-thirds of a stop.

these conditions can be corrected to a marked degree by making a duplicate. If a transparency is darker than average, use a larger aperture; if it is too light or over-exposed, use a smaller aperture or increase the flash-to-film distance. The proper exposure is a matter of judgment and experiment.

If the color is slightly off, it can be corrected quite simply by sandwiching or superimposing a soft gelatin sheet called Addacolor* in the mounting, selecting the color which will correct the fault. If the transparency is over-all blue, use yellow; if it is green, use red; if it is yellow, use blue; if it is red, use cyan.

When making duplicates, it may be necessary to use filters for proper color rendition. The right filter to use is a difficult problem and can only be decided upon by experiment. An Ansco UV/15 filter is helpful with films which have a tendency to accentuate the reds.

55 Sunset Blvd.
Ottawa 1, Ontario

*Lou Bertz Specialties, Hollywood, Calif.

READERS' ROUND TABLE

HILLSIDE, N. J.

EDITOR, THE JOURNAL OF PROSTHETIC DENTISTRY:

I respectfully call your attention to the July-August, 1960, edition of THE JOURNAL OF PROSTHETIC DENTISTRY. Please refer to page 733, "Production of Silver Surfaces on Dental Casts." Under "expendable materials," the author writes, "The plating solution consists of 15 ounces of silver cyanide dissolved in 1 quart of distilled water."

It is impossible to dissolve silver cyanide as such in distilled water. Silver cyanide is only soluble in the presence of potassium cyanide. In order to dissolve 15 ounces of silver cyanide it will be necessary to add at least 8 ounces of potassium cyanide so as to form the soluble complex salt of potassium-silver cyanide. Also, it should be stressed that a silver-plating bath must be maintained with an excess of potassium cyanide. It is also desirable to have a certain amount of potassium carbonate.

It is not my intent to take issue with the author of this article, because I too use the silver-plating method in our laboratory and am getting excellent results. However, I do believe that certain corrections pertaining to this article should be brought to the attention of your readers so they may be properly advised.

Respectfully yours,

ARTHUR KOORSE, C.D.T.

COLUMBUS, OHIO

EDITOR, THE JOURNAL OF PROSTHETIC DENTISTRY:

I am endebted to Mr. Arthur Koorse for calling attention to the inaccuracy contained in my article, "Production of Silver Surfaces on Dental Casts" (J. PROS. DEN. 10:733, 1960). He is quite correct in stating that the solubility of pure silver cyanide is very slight.

The sentence which reads, "The plating solution consists of 15 ounces of silver cyanide dissolved in 1 quart of distilled water," should read, "The plating solution consists of 15 ounces of commercial silver cyanide plating salt dissolved in 1 quart of distilled water." The preparation actually used was Kerr's silver-plating concentrate, but this information probably was not adequately implied by my third reference.

Sincerely,

DAVID C. HOPPENSTAND

BOOK REVIEW

DENTAL PRACTICE ADMINISTRATION, By Robert K. Stinaff, St. Louis and New York, 1960, The C. V. Mosby Company. Pp. 271. Price $7.50.

This excellent book is an extremely complete presentation of its subject from the opening, "A Concept of Practice Administration," to the practical and inclusive suggestions for the preparation of records of reference and timely provisions of the dentist's last will and testament. Its twenty-one chapters are unusually well organized and their carefully ordered sequence imparts an interest ordinarily found only in narrative.

Choice, practice goal, planning the office, equipment and financing, and introduction to the community are discussed in a direct and highly informative manner. Auxiliary personnel, appointment control, office procedures for handling patients, fees, payment plans and collections, and case presentation and motivation are offered in complete but concise form. The chapters relating to communications, how to gain and lose patients, lay education, office and personal business involvements, and continuing education and affiliation are also very clear and impressive. Treatment of the growth of the practice and the philosophy, ethics and jurisprudence, facing the facts, and pertinent miscellaneous topics in conclusion are likewise presented in a most readable and satisfying way.

Dental Practice Administration is one of the best publications to come to this reviewer's attention. It denotes the author's extensive experience, his ability to cover thoroughly a complex subject in simple terms, his modest and effective use of essential illustrations and forms, and a philosophy which provokes admiration. Not the least of the attributes of this worthy book are the well-selected and inspiring quotations at the end of each chapter and the list of references for recommended reading.

Neal A. Harper, D.D.S.

NEWS AND NOTES

MEETINGS

Mid-Continent Dental Congress, Chase Hotel, St. Louis, Mo., Nov. 27 to 30, 1960. For further information write to the St. Louis Dental Society, 8013 Maryland Ave., St. Louis 5, Mo.

Rowe Smith Memorial Foundation, Seventh Annual Seminar, Fly-n-Fish Lodge on Caddo Lake. Karnack, Texas, Dec. 2 to 5, 1960. For further information write to Rowe Smith Memorial Foundation, 501 State National Bank Bldg., Texarkana, Arkansas.

Greater New York Academy of Prosthodontics Meeting, New York, N. Y., Dec. 3 and 4, 1960.

American Academy of Dental Medicine Midwinter Meeting, New York, N. Y., Dec. 4, 1960. For further information write to Dr. George F. Clarke, Secretary, 554 Franklin St., Melrose 76, Mass.

Greater New York Dental Meeting, Statler Hilton Hotel, New York, N. Y., Dec. 5 to 9, 1960. For further information write to Mrs. Mabel Purdy, Executive Secretary of the Meeting, Room 106A, Statler Hilton Hotel, New York 1, N. Y.

Greater Miami Chapter of Alpha Omega, Third Annual "Sunshine Seminar," Deauville Hotel, Miami Beach, Fla., Jan. 20 to 23, 1961. The theme of this year's seminar is "Occlusion." For further information write to Dr. Irving Gordon, 420 Lincoln Rd., Miami Beach, Fla.

American Association of Endodontists, Conrad Hilton Hotel, Chicago, Ill., Feb. 2, 1961. For further information write to Dr. Edwin C. Van Valey, Secretary, 9 Rockefeller Plaza, New York 20, N. Y.

American Equilibration Society, Sheraton-Blackstone Hotel, Chicago, Ill., Feb. 2, 1961. For further information write to Dr. R. C. Van Dam, Secretary, 11431 South Halsted St., Chicago, Ill.

American Denture Society, Congress Hotel, Chicago, Ill., Feb. 3 and 4, 1961.

American Academy of Crown and Bridge Prosthodontics, Conrad Hilton Hotel, Chicago, Ill., Feb. 4 and 5, 1961.

American Academy of Restorative Dentistry, Conrad Hilton Hotel, Chicago, Ill., Feb. 4 and 5, 1961.

International Association for Dental Research, Hotel Statler, Boston, Mass., March 23 to 26, 1961.

American Association for Cleft Palate Rehabilitation, Montreal, Canada, May 4 to 6, 1961.

Academy of Denture Prosthetics, Radisson Hotel, Minneapolis, Minn., May 7 to 12, 1961.

Southeastern Academy of Prosthodontics, Americana Hotel, Miami Beach, Fla., May 18 to 21, 1961.

Australian Dental Association, 16th Australian Dental Congress, Sydney, New South Wales, Aug. 14 to 18, 1961.

17th French Congress of Stomatology, Medicine College–Eastman Institute, Paris, Autumn, 1961. For further information write to the Secrétariat du XVIIième Congrés Français de Stomatologie, Institut de Stomatologie, 20 Passage Dauphine, Paris-6ième.

ANNOUNCEMENTS

Reprints of the second edition of the *Glossary of Prosthodontic Terms* are now available. Prices: 1 to 20 copies, fifty cents each; 20 to 49 copies, forty cents each; 50 to 99 copies, thirty-five cents each; 100 or more copies, twenty-five cents each. Orders for less than 100 will be mailed prepaid; orders for 100 or more will be sent shipping charges collect. Cash, check, money order, or institution purchase order must accompany the order for reprints. Orders will not be filled otherwise. Address: Glossary Reprints, 3939 Old Brownsboro Rd., Louisville 7, Ky.

The American Association of Endodontists is sponsoring a symposium entitled "Biology of the Dental Pulp" on Thursday Feb. 2, 1961. Checks for the $25.00 fee should be made payable to the Association and forwarded to Dr. L. Parris, 1930 Chestnut St., Philadelphia, Pa.

Loyola University, Chicago College of Dental Surgery, is offering a Research and Teacher Training Program in Oral Biology. This is under a Teacher Training Grant from the National Institutes of Health. It is designed for candidates who desire a teacher's career in basic sciences or in clinical subjects. The stipends are up to $5,000 per year, and the program can lead to an advanced degree.

For further information and application write to Dr. Harry Sicher, Director, Loyola University, Chicago College of Dental Surgery, 1757 West Harrison St., Chicago 12, Ill.

Michael Reese Hospital and Medical Center presents "The Medical Laboratory in Clinical Dentistry," to be held on Feb. 9 and 10, 1961.

For further information write to Dental Department, Michael Reese Hospital, 29th St. and Ellis Ave., Chicago 16, Ill.

Competitive examinations for appointment of dentists as officers in the Regular Corps of the United States Public Health Service Commissioned Corps will be held throughout the United States Jan. 31 through Feb. 3, 1961.

POSTGRADUATE COURSES

The University of Alabama, School of Dentistry, announces the following refresher courses:

Oral Cancer, Dr. Leonard Robinson, Dec. 3 and 4, 1960.

Preventive Orthodontics, Dr. Sidney B. Finn and Dr. H. F. Hitchcock, Dec. 10 to 12, 1960.

General Anesthesia, Dr. James D. Jones and Dr. Charles A. McCallum, Jan. 7 to 9, 1961.

Crown and Bridge Prosthodontics, Dr. John F. Johnston, Jan. 20 to 22, 1961.

Oral Roentgenology, Dr. Arthur H. Wuehrmann, Jan. 28 to 30, 1961.

For further information and application write to the Director, Refresher Course Program, University of Alabama, School of Dentistry, 1919 Seventh Ave., South, Birmingham, Ala.

Boston University, School of Medicine, Division of Graduate Studies, Department of Stomatology, announces the following postgraduate courses:

Comprehensive Review of Periodontal Surgical Procedures, Dr. Jack Alloy, Dr. Jack Bloom, Dr. D. Walter Cohen, Dr. Robert Gottsegen, and Dr. Gerald M. Kramer, Nov. 18 and 19, 1960.

Full Denture Prosthesis, Dr. Chester Landy, Dec. 12 to 16, 1960.

Esthetics in Full Dentures, Dr. Eugene Tillman, Jan. 6 and 7, 1961.

Tumors in Oral Surgery, Dr. Kurt H. Thoma and Dr. Henry M. Goldman, Jan. 13 and 14, 1961.

Periodontal Pathology, Dr. Henry M. Goldman and Dr. Jack Bloom, Jan. 16 to 21, 1961.

Clinical Pathology of the Oral Mucous Membranes, Dr. Max Jacobs and Dr. Henry M. Goldman, Jan. 20 and 21, 1961.

Evaluation of Newer Dental Materials and Technics, and Factors Affecting Their Clinical Success, Dr. R. W. Phillips, Jan. 27 and 28, 1961.

Treatment Planning Clinic—Restoration of Missing Teeth, the Staff, Department of Stomatology, Feb. 17 and 18, 1961.

One-Day Review of Endodontic Procedures, Dr. Herbert Schilder, Feb. 25, 1961.

Selection of Cases and Technics for Minor Tooth Movement, Dr. Leonard Hirschfeld, March 3 and 4, 1961.

Oral Pathology for Oral Surgeons, Dr. Jack Bloom, Dr. Kurt H. Thoma, and Dr. Henry M. Goldman, March 6 to 10, 1961.

Applied Anatomy of the Head and Neck, Dr. Arthur M. Lassek, March 10 and 11, 1961.

Seminar: Review of Occlusal Concepts in Restorative Dentistry, Dr. Morton Amsterdam, Dr. Ernest R. Granger, and Dr. Edward J. Hoffman, March 17 and 18, 1961.

The Abutment Tooth, the Staff, Department of Stomatology, March 24 and 25, 1961.

The Use of Ultrasonics in Periodontal Therapy, Dr. Henry M. Goldman, April 1, 1961.

Apicoectomy-Surgical Endodontic Procedures, Dr. Herbert Schilder, April 10 to 14, 1961.

Periodontal Therapy, Dr. Henry M. Goldman, Dr. Bernard S. Chaikin, Dr. Gerald M. Kramer, Dr. William Pendergast, Dr. Jack Bloom, and associates, April 24 to 29, 1961.

Advanced Course in Periodontal Therapy, Dr. Henry M. Goldman, Dr. Bernard S. Chaikin, Dr. Gerald M. Kramer, Dr. William Pendergast, and associates, April 24 to 29, 1961.

Practice Management and Audio Analgesia, Dr. Frederick A. Trevor, April 28 and 29, 1961.

Head and Facial Pain of Dental and Non-dental Origin, Dr. Charles A. Kane and Dr. Kurt H. Thoma, May 13, 1961.

Full Mouth Reconstruction, Dr. Leo Talkov, Dr. David J. Baraban, Dr. Henry M. Goldman, Dr. Bernard S. Chaikin, Dr. Gerald M. Kramer, and Dr. J. David Kohn, May 15 to 19, 1961.

Pedodontics for the General Practitioner, Dr. Harold Berk, May 19 and 20, 1961.

Surgical Procedures in Periodontal Therapy, Dr. Lewis Fox and associates, May 22 to 26, 1961.

For further information write to Director of Postgraduate Studies, Department of Stomatology, Massachusetts Memorial Hospitals, 750 Harrison Ave., Boston 18, Mass.

New York University, College of Dentistry, announces the following postgraduate courses:

Endodontics, Dec. 1 and 2, 1960.

Complete Denture Participation, Jan. 16 to 20, 1961.

Immediate Dentures, Feb. 15 to 17, 1961.

Dental Obturators, March 15 to 17, 1961.

Partial Dentures, April 19 to 21, 1961.

For further information and application write to Director, Postgraduate Division, New York University, College of Dentistry, 421 First Ave., New York 10, N. Y.

The Ohio State University, College of Dentistry, announces the following postgraduate courses:

Oral Surgery, Dr. Morgan Allison, Nov. 28 to Dec. 2, 1960, and May 22 to 26, 1961.

Elastic Impression Materials and Technics, Dr. Thomas McBride and Dr. Donald Dickson, Dec. 7 and 8, 1960.

Crown and Bridgework, Dr. Thomas McBride, Jan. 23 to 27, 1961.

A Refresher Course in Dental Hygiene, Dr. Consuelo Wise and Dr. John Wilson, Jan. 30 and 31, 1961.

Pedodontics and Interceptive Orthodontics, Dr. Lyle Pettit and Dr. Benjamin Williams, Feb. 20 to 24, 1961.

Endodontics, Dr. J. Henry Kaiser, March 6 to 10, 1961.

Complete Denture Prosthodontics, Dr. Carl O. Boucher, April 3 to 7, 1961.

Hypnosis in Dentistry, Dr. Charles Pfersick, April 10 to 12, 1961.

Periodontics, Dr. John Wilson and Dr. William Walton, April 13 to 15, 1961.

Removable Partial Denture Prosthodontics, Dr. Victor Steffel, April 24 to 28, 1961.

General Anesthesia, Dr. Morgan Allison, May 15 to 19, 1961.

Dental Drugs in Action, Dr. W. Russell Kampfer, May 19 and 20, 1961.

For further information and application write to The Ohio State University, College of Dentistry, 305 West Twelfth Ave., Columbus 10, Ohio.

Applications are now being accepted by the Graduate Division of the University of Pittsburgh, School of Dentistry, for graduate study in the fields of Anesthesiology, Oral Surgery, Orthodontics, Periodontics, and Prosthodontics, leading to the Master of Science degree. Selection of students for the fall session of 1961 will be made in March, 1961.

A nondegree, full-time, 12 month course in General Anesthesia is also available for qualified dental graduates.

Graduate study in the preclinical basic sciences of Anatomy, Biochemistry, Microbiology, Pathology, Pharmacology, and Physiology leading to the Master of Science or Doctor of Philosophy degree is also offered through the Schools of the Health Professions. Successful applicants in this latter program are eligible for financial assistance in the form of traineeships.

For further information and application write to Director of Graduate Education, University of Pittsburgh, School of Dentistry, Pittsburgh 13, Pa.

Tufts University School of Dental Medicine announces the following postgraduate courses:

Hospital Management for the Dental Patient, Jan. 11 to 13, 1961.

The Construction of the Full Crown, Jan. 16 and 17, 1961.

A Course in Periapical Surgery, Jan. 26 and 27, 1961.

Crown and Bridge Design and Construction, Feb. 15 and 16, 1961.

Orthodontic Principles of Interest to the General Practitioner, each Wednesday, Feb. 8 through April 5, 1961.

Surgical and Prosthetic Management of Advanced Periodontal Disease, March 1 and 2, 1961.

Minor Oral Surgery, each Wednesday, March 1 through April 9, 1961.

Endodontics for the General Practitioner, March 20 to 23, 1961.

A Special Participation Course in Periodontology, April 24 to 28, 1961.

Clinical Adjustment of the Occlusion, May 3 to 5, 1961.

Special Course in Surgical Management of Skeletal Deformities, May 8 to 10, 1961.

The Diagnosis and Treatment of Pain and Other Symptoms Arising From Temporomandibular Joint Disturbances, May 23 and 24, 1961.

Full Denture Prothesis, June 5 to 9, 1961.

For further information and application write to Director of Graduate and Postgraduate Studies, Tufts University School of Dental Medicine, 136 Harrison Ave., Boston, Mass.

The Medical College of Virginia announces the following postgraduate courses:

Clinical Occlusion, Dr. Arne G. Lauritzen, Feb. 11 to 15, 1961.

Oral Surgery, Dr. Elmer Bear and Dr. W. J. Longan, March 6 to 8, 1961.

Anatomy of the Head and Neck, Dr. Alton D. Brashear, March 13 to 17, 1961.

Complete Denture Prosthesis, Dr. M. M. DeVan, March 20 to 24, 1961.

Clinical Photography, Dr. P. J. Modjeski and Mr. Melvin C. Shaffer, April 10, 1961.

For further information and application write to Dr. H. T. Knighton, Director of Postgraduate Instruction, School of Dentistry, Medical College of Virginia, Richmond, Va.

HOSPITAL INTERNSHIP AND RESIDENCY PROGRAMS

The Veterans Administration Hospital, Iowa City, Iowa, in affiliation with the State University of Iowa, College of Dentistry, announces that two rotating dental internships and one residency in Prosthetics will be available for 1 year beginning July 1, 1961.

For further information and application write to the Chief, Dental Service, VA Hospital, Iowa City, Iowa.

The Dental and Oral Surgery Service of The Mount Sinai Hospital in New York City announces that it is accepting applications for internships and residency for the calendar year beginning July, 1961.

For further information and application write to Dr. Max Fuchs, Assistant Director, The Mount Sinai Hospital, 11 East 100th St., New York 29, N. Y.

The Veterans Administration Hospital, Philadelphia, is now accepting applications for the 1 year rotating internships available July 1, 1961. The program is given in cooperation with the affiliated Dental and Medical Schools. A Certificate of Internship is awarded by the Hospital.

For further information and application write to Dr. S. L. Orlean, Chief, Dental Service, Veterans Administration Hospital, Philadelphia 4, Pa.

DIRECTORY

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Next Meeting: Radisson Hotel, Minneapolis, Minn., May 7 to 12, 1961.

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Next Meeting: Conrad Hilton Hotel, Chicago, Ill., Feb. 4 and 5, 1961.

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Associate Editor: Gilbert P. Smith, 430 West 116th St., New York, N. Y.
Next Meeting: New York, N. Y., Dec. 3 and 4, 1960.

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PART TWO *of two parts*

THE JOURNAL OF

PROSTHETIC DENTISTRY

VOLUME 10 NOVEMBER-DECEMBER, 1960 NUMBER 6

GLOSSARY OF PROSTHODONTIC TERMS

by

THE ACADEMY OF DENTURE PROSTHETICS

Edited by

THE NOMENCLATURE COMMITTEE OF THE ACADEMY OF DENTURE PROSTHETICS

CARL O. BOUCHER, D.D.S., CHAIRMAN
ARTHUR A. FRECHETTE, D.D.S.
DANIEL H. GEHL, D.D.S.

SECOND EDITION

PUBLISHED BY
THE C. V. MOSBY COMPANY, 3207 WASHINGTON BLVD., ST. LOUIS 3, U.S.A.

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The Nomenclature Committee of the Academy of Denture Prosthetics

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PREFACE TO THE SECOND EDITION

IMMEDIATELY AFTER the publication in 1956 of the first *Glossary of Prosthodontic Terms,* the Academy of Denture Prosthetics and its Nomenclature Committee began reviewing and re-examining the terms and definitions it contained. Each year certain terms were selected and studied intensively. This is as it should be because language is never static. New concepts, new techniques, and even a better understanding of old concepts and techniques require modifications in terminology in order that they may be expressed or described accurately. This edition represents the progress made in the direction of better communications during the last five years.

Many new terms and new definitions have been added in the second edition. These are the result of suggestions made by dentists everywhere as well as those made by the Fellows of the Academy of Denture Prosthetics. There will be future alterations, but in the meantime the present recommendations can be followed with the assurance that dentistry will not suffer in this field by comparison with other sciences.

A gradual improvement has been noted in the clarity of the literature of prosthetic dentistry, as careful writers and helpful editors have adopted the suggested terms in the first edition. If these practices are continued, based upon the recommendations in this and subsequent editions, the barrier of poor communications will be broken. Some of the apparent disagreement about principles, concepts, and techniques may be found to be agreement, when these are expressed clearly in terms which are universally understood.

THE NOMENCLATURE COMMITTEE
ACADEMY OF DENTURE PROSTHETICS

PREFACE TO THE FIRST EDITION

THIS GLOSSARY IS A COLLECTION of words and terms and their special connotations in the art and science of prosthodontics. It is in the nature of a progress report in a tremendous effort to standardize the nomenclature used in this field. The advantages to the dental profession of a successful effort in this direction are manifold. The most important of these is that the use of a uniform terminology would permit authors to discuss their concepts and techniques and be sure that these would be understood by those who would read the articles, regardless of the geographic location or the specialty of the reader.

The need for a glossary of terms used in prothodontics has been recognized for many years. In 1923, Ottofy* stated, "It is to be hoped that members of the profession and specialists through their organizations will reach an agreement as to the terms to be given preference or to be used exclusively." He called particular notice to the confused state of the prosthodontic terminology of that time, and it is even worse now because of the progress in the art and science of prosthodontics. Many new terms and words intended to describe or explain modern philosophies or procedures have been added to the literature. Many different interpretations and meanings have been ascribed by authors, clinicians, and teachers to the same terms and words. Many "old" terms have been given "new" definitions by contemporary authors. Many "old" terms have been redefined in the light of the increased knowledge of the problems of prosthodontics.

Through the years many sincere attempts have been made by individuals, specialty groups, and the Bureau of Library and Indexing of the American Dental Association to develop a standard and acceptable nomenclature in dentistry. The major obstacle has been the difficulty in obtaining universal acceptance of proposed interpretations.

The Academy of Denture Prosthetics has studied the problem throughout its existence and, until recently, has reached unanimous agreement on very few terms. This was in spite of sincere and valiant efforts on the part of the nomenclature committees, and it was due to the wide differences of opinion and background among those who considered the committees' recommendations. This lack of progress was most discouraging, but three years ago it was agreed by the Fellowship of the Academy that this Glossary would be prepared, and that the *majority* opinion would be adopted. This decision made possible real progress toward the ultimate goal—a universal terminology for prosthodontics.

The "workshop" technique was used in the course of two meetings of the Academy for the study of nearly 1,000 words or terms. The results of these "workshop" sessions were restudied by the Nomenclature Committee of the Academy. At least sixteen outstanding prosthodontists have given serious study to each term included in this Glossary. The definitions represent a composite of their understanding of the terms. The Fellows of the Academy of Denture Prosthetics have combined their efforts to serve as lexicographers.

*Ottofy, Louis: Standard Dental Dictionary, Chicago, 1923, Laird and Lee, Inc., p. IX.

The chief role of a lexicographer is to record the current usage of words. The chief function of words in science is to convey meaning.

The lexicographer has a duty to *lead* as well as to follow. Where clearness demands it, he should place such restrictions as are necessary to avoid ambiguity. That is, he must narrow down some definitions so they will not carry too much generality. Where voids exist, he should fill them in. Where more than one term is used to express the same idea or concept, he should indicate the preference on the basis of logic and other considerations.

Many instances could be cited in the Glossary where the Academy and its Nomenclature Committee have performed these various "duties" of the lexicographer. Certain terms were determined to be objectionable for some reason and are marked (Obj.). Some new terms have been added which seem to express the desired ideas or meanings more accurately than the corresponding terms in current usage. Where more than one term which carries the same connotation was found, the *preferred* term is listed first. Likewise, when more than one definition was assigned to the same term, the preferred definition is listed first. These decisions were made on the basis of *majority* opinion. It is hoped that eventually obsolete or objectionable terms and terms which tend to mislead and confuse will be eliminated entirely.

This, the first edition of the Glossary, is offered to the dental profession for its consideration. Since it is recognized that there are some terms which have not been included, and that some other terms and definitions which may be objectionable to some authorities have been included, revisions will be necessary from time to time. Constructive suggestions are invited, and these will be given thorough consideration in future editions. In its present form, this Glossary can serve as a good temporary standard.

It is impossible to give due credit here to all who have worked to make this Glossary possible. The Fellows of the Academy of Denture Prosthetics have supplied the fundamental information and have made the necessary decisions. The Editorial Council of THE JOURNAL OF PROSTHETIC DENTISTRY, and the C. V. Mosby Company, its publisher, have provided encouragement and technical assistance in its development. Special acknowledgment is due to Dr. George B. Denton of the Bureau of Library and Indexing of the American Dental Association, for his advice and counsel, and to Mrs. Marice K. Musgrove and Miss Barbara Eichhorn for the tremendous amount of secretarial work which was necessary. Acknowledgment is made, also, to certain dictionaries and textbooks from which the definitions for some of the terms have been taken. These are: Dorland, W. A. Newman, The American Illustrated Medical Dictionary, ed. 22, Philadelphia, 1951, W. B. Saunders Co. (Dor.); Dunning, William B., and Davenport, S. Ellsworth, Jr., A Dictionary of Dental Science and Art, Philadelphia, 1936, P. Blakiston's Son & Co., Inc. (D. & D.); Swenson, Merrill G., and Terkla, Louis G., Partial Dentures, St. Louis, 1955, The C. V. Mosby Co. (S.); *Blakiston's* New Gould Medical Dictionary, ed. 1, Philadelphia, 1949, The Blakiston Co. (Gould). To all of these, the Nomenclature Committee expresses its gratitude.

THE NOMENCLATURE COMMITTEE
ACADEMY OF DENTURE PROSTHETICS

GLOSSARY
of
PROSTHODONTIC TERMS

A

abrasion The grinding or wearing away of tooth substance by mastication, incorrect tooth-brushing methods, or similar causes.

abrasive A substance used for abrading, grinding, or polishing.

absorption The taking up of fluids or other substances by the skin, mucous surfaces, absorbent vessels, or dental materials.

abutment A tooth used for the support or anchorage of a fixed or removable prosthesis.

intermediate a. A natural tooth, without other natural teeth in proximal contact, which is used as an abutment, in addition to two primary abutments.

primary a. A tooth used for the support or anchorage of a fixed or removable partial denture appliance.

accelerator 1. A catalytic agent used to hasten a chemical reaction (e.g., NaCl or K_2SO_4 added to plaster of Paris and water to hasten setting). 2. A substance used to speed chemical reaction.

acentric relation (Obj.) (See *eccentric relation*)

acquired centric relation (Obj.) (See *eccentric relation*) (See also *centric relation*)

acrylic Improperly used as a noun. Should be used as in *acrylic resin, acrylic resin denture, acrylic resin tooth,* etc.

adhesion 1. The physical attraction of unlike molecules for one another. 2. The molecular attraction existing between the surfaces of bodies in contact.

adjustable axis face-bow (See *face-bow, hinge-bow*)

adjustment A modification made upon a denture, or upon the teeth on a denture after it has been completed and inserted in the mouth.

occlusal a. Modification of the occluding surfaces of teeth to develop harmonious relationships between these surfaces.

air-chamber (Obj.), **relief chamber** (See *relief*)

alginate (See *hydrocolloid*) 1. An irreversible hydrocolloid consisting of salts of alginic acid. 2. In dentistry, it is used primarily for making impressions.

alveolar bone The specialized bone structure which supports the teeth.

alveolar ridge (See *ridge*)

alveolus The socket in the bone in which the teeth are attached by means of the periodontal membrane.

anatomic crown (See *crown*)

anatomic teeth (See *teeth*)

anneal The softening of a metal by controlled heating and cooling. The process makes a metal more easily adapted, bent, or swaged and less brittle.

anterior guide That part of an articulator on which the anterior guide pin rests to maintain the vertical dimension of occlusion. The guide influences the degree of separation of the casts in eccentric relationships. (See *incisal guide*)

adjustable a. g. An anterior guide whose superior surface may be varied to provide desired separation of the casts in various eccentric relationships.

anti-Monson curve (Obj.) (See *reverse curve*)

appliance A device used to provide function or for therapeutic purposes (e.g., dental prosthesis, fixation splint, removable occlusal overlay, obturator). (See *restoration*)

apposition The condition of being placed or fitted together; juxtaposition; coadaptation.

arch form The shape of the dental arch.

arrow point tracer (See *tracer* and *needle point*)

articulate (Obj.) (See *tooth arrangement*)

articulation (See *tooth arrangement*)

anatomic a. A rigid or movable junction of bony parts.

articulator a. The use of a device which incorporates an artificial temporomandibular joint permitting the orientation of casts in a manner duplicating or simulating various positions or movements of the mandible.

dental a. The contact relationship of the upper and lower teeth when moving into and away from centric occlusion.

speech a. Enunciation of distinct connected speech.

temporomandibular a., temporomandibular joint 1. The joint formed by the mandibular condyle and the glenoid fossa. 2. The articulation of the condyloid process of the mandible and the interarticular disk with the mandibular fossa of the temporal bone.

articulator A mechanical device which represents the temporomandibular joints and jaw members to which maxillary and mandibular casts may be attached.

adjustable a. 1. An articulator which may be adjusted to permit movement of the casts into recorded eccentric relationships. 2. An articulator capable of adjustment to more than one eccentric position.

artificial dentition (Obj.) (See *denture*)

artificial denture (Obj.), **complete denture** (See *denture*)

artificial stone A specially calcined gypsum derivative similar to plaster of Paris with a physical difference in that the grains are nonporous, thereby resulting in a product which is stronger than plaster of Paris.

artificial teeth (See *teeth*)

atrophy A diminution in size of cell, tissue, organ, or part.

adipose a. Atrophy due to reduction in fatty tissue.

bone a. Bone resorption both internally in density and externally in form, viz., of residual ridges.

muscular a. A wasting of muscular tissue, especially due to lack of use.

postmenopausal a. A thinning of the oral mucosa following the menopause.

senile a. 1. The normal atrophy of all tissues due to advanced age. 2. The normal diminution of all tissues due to advanced age.

attachment A mechanical device for the fixation and stabilization of a dental prosthesis.

precision a., internal a., frictional a., slotted a., key and keyway a., parallel a. 1. A frictional retainer used in fixed and removable denture construction; consists of closely fitting male and female parts, the latter of which is contained usually within the normal or expanded contours of the crown of the abutment tooth. 2. A frictional retainer used in fixed and removable partial denture construction that consists of closely fitting male and female parts. 3. One that depends upon resistance between parallel walls of male and female parts.

autopolymer A plastic (resin) which polymerizes without external heat, as a result of the addition of an activator and a catalyst.

autopolymer resin (See *resin*)

autopolymerization Polymerization without the use of external heat, as a result of the addition of an activator and a catalyst.

axis A straight line around which a body may rotate.

condylar a. A line through the two mandibular condyles around which the mandible may rotate during a part of the opening movement.

hinge a. An imaginary line between the mandibular condyles around which the mandible can rotate without translatory movement.

opening a. An imaginary line around which the condyles may rotate during opening and closing movements of the mandible.

B

backing A metal support which serves to attach a facing to a prosthesis.

balance (Obj.) This term has no value in prosthodontics unless it is combined with another word or phrase, e.g., occlusal balance. (See *occlusion*)

balanced articulation (Obj.) (See *balanced occlusion*)

balanced bite (Obj.) (See *balanced occlusion*)

balanced occlusion (See *occlusion*) 1. An occlusion of the teeth which presents a harmonious relation of the occluding surfaces in centric and eccentric positions within the functional range. 2. The simultaneous contacting of the upper and lower teeth on the right and left and in the anterior and posterior occlusal areas. It is thought of primarily in the mouth, but may be arranged and observed on articulators. 3. The simultaneous contacting of the upper and lower teeth on the right and left and in the anterior and posterior occlusal areas. This occlusion is developed to prevent a tipping or rotating of the denture bases in relation to the supporting structures. It is thought of primarily in the mouth, but it is arranged and may be observed on articulators. 4. Occlusion of the teeth which presents harmonious relationships of opposing surfaces during mastication or the act of swallowing.

mechanically b. o. A balanced occlusion without reference to physiologic considerations, as on an articulator.

physiologically b. o. A balanced occlusion which is in harmony with the temporomandibular joints and the neuromuscular system.

balancing contacts 1. The contacts between upper and lower dentures on the balancing side for the purpose of stabilizing the dentures. 2. The contacts between upper and lower dentures at the opposite side from the working side (anteroposteriorly or laterally) for the purpose of stabilizing the dentures. 3. The contacts between upper and lower natural or artificial teeth at the opposite side from the working side.

balancing occlusal surfaces (Obj.) (See *balancing contacts*)

balancing side The side opposite the working side of the dentition or denture. (See *working side*)

bar A metal segment of greater length than width which serves to connect two or more parts of a removable partial denture. (See *major connector*)

clasp b. (Obj.) (See *clasp*)

connector b. (Obj.) (See *minor connector*)

labial b. A major connector located labial to the dental arch joining two or more bilateral parts of a mandibular removable partial denture.

lingual b. A major connector located lingual to the dental arch joining two or more bilateral parts of a mandibular removable partial denture.

palatal b. A major connector which crosses the palate and unites two or more parts of a maxillary removable partial denture.

bar clasp arm (See *clasp*)

basal bone The osseous tissue of the mandible and maxillae excepting the alveolar processes.

basal seat (See *denture-supporting area*)

basal seat area That portion of the oral structures which is available to support a denture.

basal seat outline The outline on the mucous membrane or on a cast of the entire area to be covered by a denture.

basal surface The surface of the denture whose detail is determined by the impression and which rests upon the basal seat.

base material Any substance from which a denture base may be made, such as shellac, acrylic resin, vulcanite, polystyrene, metal, etc.

baseplate, record base, temporary base, trial base A temporary form representing the base of a denture which is used for making maxillomandibular (jaw) relation records and for the arrangement of teeth.

stabilized b. A baseplate lined with a plastic material to improve its fit and stability.

Bennett angle The angle formed by the sagittal plane and the path of the advancing condyle during lateral mandibular movement as viewed in the horizontal plane.

Bennett movement The bodily lateral movement or lateral shift of the mandible resulting from the movements of the condyles along the lateral inclines of the mandibular fossae in lateral jaw movement.

Bimeter gnathodynamometer (See *gnathodynamometer*)

biology The science of life or living matter in all its forms and phenomena.

biometrics The science of the application of statistical methods to biologic facts.

biophysics, biomechanics 1. The science which deals with the forces which act on living cells of the living body. 2. The relationship between the biologic behavior of living structures and the physical influence to which they are subjected.

dental b., b. The relationship between the biologic behavior of oral structures and the physical influence of a dental restoration.

biscuit bite (Obj.) (See *maxillomandibular record*)

bite (Obj.) (See *interocclusal record, checkbite, maxillomandibular registration, denture space, interarch distance*) The term "bite" should be reserved for the act of incision, a morsel of food, and in connection with discussions of the amount of pressure developed in closing the jaws, etc.

bite analysis (Obj.) (See *occlusal analysis*)

bite block (Obj.) (See *occlusion rim*)

bite closing (Obj.) (See *vertical dimension decrease*)

bite fork (Obj.) (See *face-bow fork*)

bite opening (Obj.) (See *vertical dimension increase*)

bite raising (Obj.) (See *vertical dimension increase*)

bite rim (Obj.) (See *occlusion rim*)

biting pressure (Obj.) (See *occlusal pressure*)

biting strength (Obj.) (See *masticatory force*)

Bonwill triangle An equilateral triangle bounded by lines from the contact points of the lower central incisors, or the medial line of the residual ridge of the mandible, to the condyle on either side and from one condyle to the other.

border The circumferential margin or edge.

b. molding The shaping of an impression material by the manipulation or action of the tissues adjacent to the borders of an impression.

b. seal The contact of the denture border with the underlying or adjacent tissues to prevent the passage of air or other substances.

border tissue movements The action of the muscles and other tissues adjacent to the borders of a denture.

boxing (an impression) The building up of vertical walls, usually in wax, around the impression to produce the desired size and form of the base of the cast, and to preserve certain landmarks of the impression.

boxing wax Wax used for boxing impressions.

bracing Resistance to horizontal components of masticatory force.

bridge (Obj.), **fixed partial denture** (See *partial denture*)

bruxism A clenching of the teeth associated with forceful lateral or protrusive jaw movements which results in rubbing, gritting, or grinding together of teeth, usually during sleep. (Grinding the teeth during sleep is a pathologic condition.)

bruxomania Grinding of the teeth as a neurotic symptom.

buccal 1. Pertaining to, or adjacent to, the cheek.

buccal flange (See *flange*)

buccal surface (of dentures) The side of a denture adjacent to the cheek.

buccolingual relationship The position of a space or tooth in relation to the tongue and the cheek.

butt 1. To place directly against the tissues covering the alveolar ridge. 2. To bring any two square-ended surfaces in contact, as in a butt joint.

C

Camper's line The line running from the inferior border of the ala of the nose to the superior border of the tragus of the ear.

capillary attraction That quality or state, which, because of surface tension, causes elevation or depression of the surface of a liquid that is in contact with a solid.

case (Obj.) 1. Not a good term to use to refer to a stage of prosthetic work. Patient, flask, denture, casting, etc., are better terms as they may apply. 2. A particular instance of disease or injury, as a case of typhoid fever. A case is not synonymous with a patient, for the latter is the human being affected with the disease.

cast 1. An object formed or poured in a matrix or impression, as of metal, plaster, etc. 2. A positive likeness of some desired form. 3. A positive reproduction of the form of the tissues of the upper or lower jaw, which is made in an impression, and over which denture bases or other dental restorations may be fabricated.

dental c. A positive likeness of a part or parts of the oral cavity.

diagnostic c. A positive likeness of dental structures for the purpose of study and treatment planning.

master c. A replica of the prepared tooth surfaces, residual ridge areas, and/or other parts of the dental arch as reproduced from an impression.

refractory c. 1. A cast made of material which will not disintegrate at temperatures used in casting and/or soldering. 2. A cast made of material which will tolerate the temperatures used in casting and/or soldering. 3. A cast made of a material that will withstand high temperatures without disintegrating.

study c. (See *diagnostic cast*)

casting 1. A metallic object formed in a mold. 2. The act of forming a casting in a mold.

vacuum c. The casting of a metal in the presence of a vacuum.

casting flask (See *flask, refractory*)

casting ring (See *flask, refractory*)

casting wax A composition containing various waxes with controlled properties of thermal expansion and contraction, used in making patterns to determine the shape of metal castings.

cement 1. A material which in hardening produces a mechanical interlocking effect. 2. A material which on becoming hard will usefully fill a space or bind adjacent objects together. 3. A type of filling material, e.g., silicate c.

cementation 1. The process of attaching parts by means of a cement. 2. Attaching a restoration to natural teeth by means of a cement.

central bearing Application of forces between the maxillae and mandible at a single point which is located as near as possible to the center of the supporting areas of the upper and lower jaws. It is used for the purpose of distributing closing forces evenly throughout the areas of the supporting structures during the registration and recording of maxillomandibular (jaw) relations and during the correction of occlusal errors.

central-bearing device A device which provides a central point of bearing, or support, between upper and lower occlusion rims. It consists of a contacting point which is attached to one occlusion rim and a plate which provides the surface on which the bearing point rests or moves.

c.-b. tracing device A central-bearing device which is used for making a tracing and/or for support between occlusion rims.

central-bearing point The contact point of a central-bearing device.

centric (Obj.) (The word "centric" is an adjective and should be used in conjunction with a noun.) (See *centric position, centric relation, centric occlusion*)

centric checkbite (Obj.) (See *maxillomandibular record, interocclusal record*)

centric jaw relation (See *jaw relation*)

centric occlusion (See *occlusion*)

centric position The position of the mandible in its most retruded relation to the maxillae.

centric relation (See *eccentric relation*) 1. The most retruded relation of the mandible to the maxillae when the condyles are in the most posterior unstrained position in the glenoid fossae from which lateral movement can be made, at any given degree of jaw separation.

2. The most retruded relation of the mandible to the maxillae from which the patient can make lateral jaw movements. 3. The most posterior relation of the mandible to the maxillae at the established occlusal vertical dimension. 4. The most retruded unstrained relation of the mandible to the maxillae at a given degree of vertical opening. 5. The most retruded relation of the mandible to the maxillae at a given degree of vertical opening. 6. The most retruded voluntary relation of the mandible to the maxillae. 7. Any most retruded functional relation of the mandible to the maxillae.

checkbite (Obj.) (See *interocclusal record*)

chewing cycle A complete course of movement of the mandible during a single masticatory stroke.

chewing force The degree of force applied by the muscles of mastication during the mastication of food.

circumferential clasp (See *clasp*)

clasp 1. A part of a removable partial denture which acts as a direct retainer and/or stabilizer for the denture by partially surrounding or contacting an abutment tooth. 2. A direct retainer of a removable partial denture, usually consisting of two arms joined by a body which connects with an occlusal rest. At least one arm of a clasp usually terminates in the infrabulge (gingival convergence) area of the tooth enclosed.

bar c. 1. A clasp whose arms are bar type extensions from major connectors or from within the denture base; the arms pass adjacent to the soft tissues and approach the point of contact on the tooth in a gingivo-occlusal direction. 2. A clasp which consists of two or more separate and distinct arms located opposite to each other on the tooth. The bar arms arise from the framework or a connector and may traverse the soft tissue. One arm (bar) usually terminates in the infrabulge (gingival convergence) area of the tooth and is retentive, and the other usually on the suprabulge (occlusal convergence) area, and acts as a reciprocal arm.

b. c. arm A clasp arm which has its origin in the denture base or major connector. It consists of the arm which traverses but does not contact the gingival structures, and a terminal end which approaches its contact with the tooth in a gingivo-occlusal direction.

circumferential c. 1. A clasp that encircles more than 180 degrees of a tooth, including opposite angles, and which usually contacts the tooth throughout the extent of the clasp, at least one terminal being in the infrabulge (gingival convergence) area. 2. A clasp consisting of two circumferential clasp arms, both of which originate from the same minor connector, and are located on opposite surfaces of the abutment tooth.

c. c. arm A clasp arm which has its origin in a minor connector and which follows the contour of the tooth approximately in a plane perpendicular to the path of insertion of the partial denture.

retentive c. c. a. A circumferential clasp arm which is flexible and engages the infrabulge at the terminal end of the arm.

stabilizing c. c. a. A circumferential clasp arm which is relatively rigid and embraces the height of contour of the tooth.

clasp guide line (See *survey line*)

cleft palate impression (See *impression*)

cleft palate prosthesis (See *prosthesis*)

clinical crown (See *crown*)

close bite (Obj.), **small interarch distance** (See *interarch distance*)

closed bite (Obj.) (See *reduced interarch distance*)

comminution of food The reduction of food into small parts.

compensating curve (See *curve, Monson curve*)

complete denture (See *denture*)

complete deture impression (See *impression*)

complete denture prosthesis (See *prosthesis, denture*)

component of force 1. One of the factors from which a resultant force may be compounded or into which it may be resolved. 2. One of the vectors into which a force may be resolved.

components of mastication (See *mastication*)

components of occlusion The various factors which are involved in occlusion, such as the temporomandibular joint, the associated neuromusculature, the teeth, and the denture-supporting structures.

compression molding 1. The act of pressing or squeezing together to form a shape in a mold. 2. The adaptation of a plastic material to the negative form of a split mold by pressure. (See also *injection molding*)

compression of tissue (Obj.) (See *displaceability of tissue*)

condylar guidance, condylar guide The mechanical device on an articulator which is intended to produce similar guidances in articulator movement as are produced by the paths of the condyles in the temporomandibular joints.

condylar guidance inclination, condylar guide inclination The angle of inclination of the condylar guidance to an accepted horizontal plane.

condyle The rounded articular surface at the articular end of a bone.

mandibular c. The articular process of the mandible.

condyle axis (Obj.), **condylar axis** (See *axis*)

condyle chord (Obj.), **condylar axis** (See *axis*)

condyle head (Obj.) (See *condyle*)

condyle path The path traveled by the mandibular condyle in the temporomandibular joint during the various mandibular movements.

connector A part of a partial denture which unites its components.

major c. A plate or bar (lingual bar, palatal bar) used for the purpose of uniting the partial denture bases.

minor c. The connecting link (tang) between the major connector or base of a partial denture and other units of the prosthesis, such as clasps, indirect retainers, and occlusal rests.

connector bar (See *bar*)

continuous bar retainer (See *retainer*)

continuous clasp (Obj.) (See *continuous bar retainer*)

continuous gum denture (See *denture*)

contour n. The external shape or form of an object. v. To create the external shape or form of an object, as of a denture.

contraction (muscle) The development of tension in a muscle in response to a nervous stimulus.

isometric c. An increase in muscular tension at the same muscle length, as in clenching the teeth together.

isotonic c. An increase in muscular tension during movement without resistance (either lengthening or shortening), as in free opening and closing of the mandible.

postural c. Maintenance of muscular tension (usually isometric) sufficient to maintain posture.

contracture A permanently shortened muscle.

coordination The ability to function harmoniously, as of muscles.

cope The upper half of a flask in the casting art, and hence applicable to the upper or cavity side of a denture flask.

coping A thin metal covering or cap.

transfer c. A metallic, acrylic resin, or other covering or cap used to position a die in an impression.

core 1. A metal casting, usually with a post in the canal of a root, designed to retain an artificial crown. 2. A sectional record, usually of plaster of Paris or one of its derivatives, of the relationships of parts, such as teeth, metallic restorations, or copings.

Costen's syndrome (Obj.) Various symptoms of discomfort, pain, or disease claimed by Costen to be caused by loss of vertical dimension or lack of posterior tooth occlusion.

counterdie The reverse image of a die, usually made of a softer and lower fusing metal than the die. (See *die*)

crazing (of plastic teeth) Minute cracks appearing on the surface of plastic teeth.

cross-bite teeth (See *teeth*)

crown The part of a tooth which is covered with enamel and normally projects beyond the gum line.

anatomic c. The portion of a natural tooth which extends from its dentinoenamel junction to the occlusal surface or incisal edge.

artificial c. A fixed restoration of the major part or of the entire coronal part of a natural tooth; usually of gold, porcelain, or acrylic resin.

clinical c., extra-alveolar c. The portion of a tooth which extends occlusally or incisally from the junction of the tooth root and the supporting bone.

crown flask (See *flask*)

cure (See *process*)

curve A nonangular deviation from a straight line or surface.

compensating c. The anteroposterior and lateral curvature in the alignment of the occluding surfaces and incisal edges of artificial teeth which is used to develop balanced occlusion.

Pleasure C. (Obj.) (See *reverse c.*) An occlusal curve described by Pleasure.

reverse c. A curve of occlusion which is convex upward.

curve of occlusion 1. A curved surface which makes simultaneous contact with the major portion of the incisal and occlusal prominences of the existing teeth. 2. The curve of a dentition on which the occlusal surfaces lie.

curve of Spee Anatomic curvature of the occlusal alignment of teeth beginning at the tip of the lower cuspid and following the buccal cusps of the natural bicuspids and molars, continuing to the anterior border of the ramus as described by von Spee.

cusp angle 1. The angle made by the slopes of a cusp with the plane which passes through the tip of the cusp and which is perpendicular to a line bisecting the cusp, measured mesiodistally or buccolingually. 2. The angle made by the slopes of a cusp with a perpendicular line bisecting the cusp, measured mesiodistally or buccolingually. 3. One-half of the included angle between the buccal and lingual or mesial and distal cusp inclines.

cusp height 1. The shortest distance between the tip of a cusp and its base plane. 2. The shortest distance between the deepest part of the central fossa of a posterior tooth and a line connecting the points of the cusps of the tooth.

cuspal interference (See *deflective occlusal contact*)

cuspless teeth (See *teeth*)

D

deflective occlusal contact (See *interceptive occlusal contact*) A condition of tooth contacts which diverts the mandible from a normal path of closure to centric jaw relation.

dental arch 1. The curved contour of the natural dentition or of the residual ridge. 2. The composite structure of the natural dentition and the residual ridge, or the remains thereof after the loss of some or all of the natural teeth.

dental dysfunction 1. Abnormal functioning of dental structures. 2. Partial disturbance or impairment of the functioning of a dental organ.

dental engineering 1. The application of physical, mechanical and mathematical principles to dentistry. 2. The application of engineering principles to dentistry.

dental geriatrics 1. Treatment of dental problems peculiar to advanced age. 2. Dentistry for the aged.

dental prosthesis (See *prosthesis*)

dental prosthetic laboratory procedures The steps in the fabrication of a dental prosthesis which do not require the presence of the patient for their accomplishment.

dental senescence That condition of the teeth and associated structures in which there is deterioration due to aging or premature aging processes.

dentition 1. Natural teeth in the dental arch. 2. The natural teeth in position in the dental arches.

artificial d. (Obj.) An artificial substitute for the natural dentition.

natural d. The natural teeth, as considered collectively, in the dental arch; may be deciduous, permanent, or mixed.

dentulous A condition in which natural teeth are present in the mouth.

denture An artificial substitute for missing natural teeth and adjacent tissues.

complete d. A dental prosthesis which replaces the lost natural dentition and associated structures of the maxillae or mandible.

continuous gum d. An artificial denture consisting of porcelain teeth and tinted porcelain denture base material, fused to a platinum base.

d. base 1. That part of a denture which rests on the oral mucosa and to which teeth are attached. 2. That part of a complete or partial denture which rests upon the basal seat and to which teeth are attached.

d. border, d. edge 1. The limit or boundary or circumferential margin of a denture base. 2. The margin of the denture base at the junction of the polished surface with the impression (tissue) surface. 3. The extreme edges of a denture base at the buccolabial, lingual, and posterior limits. 4. The extreme margins of a denture base.

d. foundation surface, d. basal surface That portion of the surface of a denture which has its contour determined by the impression.

d. impression surface That portion of the surface of a denture which has its contour determined by the impression. It includes the borders of the denture and extends to the polished surface.

d. occlusal surface That portion of the surface of a denture or dentition which makes contact or near contact with the corresponding surface of the opposing denture or dentition.

d. polished surface That portion of the surface of a denture which extends in an occlusal direction from the border of the denture and includes the palatal surface. It is the part of the denture base which is usually polished and includes the buccal and lingual surfaces of the teeth.

duplicate d. 1. A second denture intended to be a copy of the first denture. 2. A second denture identical with the first.

immediate d., immediate insertion d. A dental prosthesis constructed for insertion immediately following removal of natural teeth.

partial d. 1. A dental prosthesis which restores one or more, but less than all, of the natural teeth and/or associated parts and which is supported by the teeth and/or the mucosa; it may be removable or fixed. 2. A dental prosthesis which supplies artificial substitutes for one or more of the lost natural teeth and their related structures. 3. A prosthesis which replaces one or more, but less than all, of the natural teeth and associated structures, and which is supported by the teeth and/or mucosa; may be removable or fixed. 4. An artificial replacement of the missing parts but less than all of an incomplete natural dentition and adjacent tissues.

distal extension p. d. A removable partial denture that is retained by natural teeth at one end of the denture base segments only, and in which a portion of the functional load is carried by the residual ridge.

fixed p. d. A restoration of one or more missing teeth which cannot be readily removed by the patient or dentist; it is permanently attached to natural teeth or roots which furnish the primary support to the appliance.

removable p. d. 1. A dental prosthesis which artificially supplies teeth and associated structures in a partially edentulous jaw, and which can be removed from the mouth and replaced at will. 2. A partial denture so designed that it may be removed from the mouth.

unilateral p. d. A dental prosthesis restoring lost or missing teeth on one side of the arch only.

denture base (See *denture*)

denture-bearing area (Obj.) (See *denture foundation area*)

denture characterization Modification of the form and color of the denture base and teeth to produce a more lifelike appearance.

denture curing (See *process*) The process by which the denture-base materials are hardened to the form of a denture in a denture mold.

denture design A planned visualization of the form and extent of a dental prosthesis, arrived at after a study of all factors involved.

denture edge (See *denture border*)

denture esthetics (See *esthetics*)

denture flange (See *flange*)

denture foundation That portion of the oral structures which is available to support a denture.

denture foundation area That portion of the basal seat that supports the complete or partial denture base under occlusal load.

denture packing (See *packing*)

denture processing (See *process*)

denture prognosis (See *prognosis*)

denture retention 1. The means by which dentures are held in position in the mouth. 2. The maintenance of a denture in its position in the mouth. 3. The resistance of the movement of a denture from its basal seat, especially in a vertical direction.

partial d. r. The fixation of a removable partial denture by the use of clasps, indirect retainers, or precision attachments.

denture service Those procedures which are involved in the diagnosis, construction, and maintenance of artificial substitutes for missing natural teeth.

denture space 1. That portion of the oral cavity which is, or may be, occupied by a maxillary and/or mandibular dentures(s). 2. The space between the residual ridges which is available for dentures. (See also *interarch distance*)

denture stability 1. The resistance to the movement of a denture on its basal seat. 2. A condition in which a denture is maintained in a state of equilibrium in relation to the basal seat and/or abutment teeth.

denture-supporting area (See *denture foundation*)

denture-supporting structures The tissues, either teeth and/or residual ridges, which serve as the foundation for removable partial or complete dentures.

diagnosis A scientific evaluation of existing conditions.

diagnostic cast (See *cast*)

diastema A space between two adjacent teeth in the same dental arch.

die The positive reproduction of the form of a prepared tooth in any suitable hard substance, usually in metal or specially prepared artificial stone. (See *counterdie*)

dimensional stability The property of a material to retain its size and form.

direct bone impression An impression of denuded bone, used in the construction of denture implants.

direct retention (See *retention*)

displaceability of tissue The property of tissue which permits it to be moved from an initial position.

distal 1. Away from the median sagittal plane of the face following the curvature of the dental arch. 2. In a dorsal direction from any given point of reference.

distal end The posterior extremity of a dental appliance.

distal extension partial denture (See *partial denture*)

drag The lower or cast side of a denture flask.

duplicate denture (See *denture*)

dynamic relations Relations of two objects involving the element of relative movement of one object to another as the relationship of the mandible to the maxillae.

E

eccentric checkbite (Obj.) (See *interocclusal record*)

eccentric jaw relation (See *jaw relation*)

eccentric occlusion (See *occlusion*)

eccentric relation, eccentric position Any relation of the mandible to the maxillae other than centric relation. (See *centric relation*)

acquired e. r. An eccentric relation that is assumed by habit in order to bring the teeth into centric occlusion.

edentulate (Obj.) (See *edentulous*)

edentulous Without teeth, lacking teeth.

edge-to-edge bite (Obj.) (See *edge-to-edge occlusion*)

edge-to-edge occlusion An occlusion in which the anterior teeth of both jaws meet along their incisal edges when the teeth are in centric occlusion.

elastic Susceptible of being stretched, compressed, or distorted and then tending to assume an original shape.

e. limit The greatest stress to which a material may be subjected and still be capable of returning to its original dimensions when the forces are released.

elasticity The quality or condition of being elastic.

physical e. of muscle The physical quality of muscle of being elastic, of yielding to passive physical stretch.

physiologic e. of muscle The biologic quality, unique for muscle, of being able to change and resume size under neuromuscular control.

total e. of muscle The combined effect of physical and physiologic elasticity of muscle.

electromyography The recording of the electric currents set up by muscular activity.

end-to-end bite (Obj.) (See *edge-to-edge occlusion*)

end-to-end occlusion (Obj.) (See *edge-to-edge occlusion*)

environment The aggregate of all the external conditions and influences affecting the life and development of an organism.

equilibration Achieving of equilibrium of pressure.

occlusal e. The modification of occlusal forms of teeth by grinding with the intent of equalizing occlusal stress or of producing simultaneous occlusal contacts or of harmonizing cuspal relations.

equilibrator An instrument or device used in achieving or maintaining a state of equilibrium.

equilization of pressure The act of equalizing or evenly distributing pressure.

esthetic denture A denture which viewed in the mouth adds to the patient's charm, beauty, dignity, or naturalness of character.

esthetics 1. The branch of philosophy dealing with beauty, especially with the components thereof, viz., color and form. 2. The qualities involved in the appearance of a given restoration.

denture e. The cosmetic effect produced by a dental prosthesis which affects the desirable beauty, charm, character, and dignity of the individual.

etiologic factors The elements or influences that can be assigned as the cause or reason for a disease or lesion.

examination Scrutiny or investigation for the purpose of making a diagnosis.

F

face-bow 1. A caliper-like device which is used to record the relationship of the maxillae to the temporomandibular joints. 2. A caliper-like device which is used to record the relationship of the jaws to the temporomandibular joints and to orient the casts in this same relationship to the opening axis of the articulator.

f.-b. record A registration by means of a face-bow of the position of the hinge axis and/or the condyles. The face-bow record is used to orient the maxillary cast to the opening and closing axis of the articulator.

hinge-bow, adjustable axis f.-b., kinematic f.-b. (Obj.) A face-bow whose caliper ends can be adjusted to permit location of the axis of rotation of the mandible.

face-bow fork The part of the face-bow assemblage used to attach the occlusion rim to the face-bow proper.

face form 1. The outline form of the face. 2. The outline form of the face from an anterior view.

facial profile 1. The outline form of the face from a lateral view. 2. The sagittal outline form of the face.

festoons Carvings in the base material of a denture which simulate the contours of the natural tissues which are being replaced by the denture.

final flask closure The last closure of a flask before curing after trial packing the mold with a denture-base material.

final impression (See *impression*)

finish (of a denture) The final perfection of the form of the polished surfaces of a denture.

fit The adaptation of any dental restoration. (Viz., adaptation of an inlay to the cavity preparation in a tooth or adaptation of a denture to its basal seat.)

fixed partial denture (See *partial denture*)

flabby tissue (Obj.) (See *tissue, hyperplastic*)

flange That part of the denture base which extends from the cervical ends of the teeth to the border of the denture.

- **buccal f.** The portion of the flange of a denture which occupies the buccal vestibule of the mouth.
- **denture f.** 1. The essentially vertical extension from the body of the denture into one of the vestibules of the oral cavity. Also, on the lower denture, the essentially vertical extension along the lingual side of the alveololingual sulcus. 2. The buccal and labial vertical extension of upper or lower denture base, and the lingual vertical extension of the lower one. The buccal and labial denture flanges have two surfaces: the buccal or labial surface and the basal seat surface. The lower lingual flange also has two surfaces: the basal seat surface and the lingual surface.
- **f. contour** The design of the flange of a denture.
- **labial f.** The portion of the flange of a denture which occupies the labial vestibule of the mouth.
- **lingual f.** The portion of the flange of a mandibular denture that occupies the space adjacent to the tongue.

flask 1. A metal case or tube used in investing procedures. 2. A sectional metal case in which a sectional mold is made of artificial stone or plaster of Paris for the purpose of compressing and processing dentures or other resinous restorations.

- **denture f., crown f.** A sectional metal boxlike case in which a sectional mold is made of plaster of Paris or artificial stone for the purpose of compressing and curing dentures or other resinous restorations.
- **refractory f., casting f., casting ring** A metal tube in which a refractory mold is made for casting metal dental restorations or appliances.

flask closure The procedure of bringing the two halves or parts of a flask together.

- **trial f. c.** Preliminary closures made for the purposes of eliminating excess denture-base material, and to ensure that the mold is completely filled.

flasking 1. The act of investing in a flask. 2. The process of investing the cast and a wax denture in a flask preparatory to molding the denture-base material into the form of the denture.

foil 1. An extremely thin, pliable sheet of metal.

- **gold f.** 1. Pure gold rolled into extremely thin sheets. 2. A precious metal foil used in the restoration of carious or fractured teeth.
- **platinum f.** 1. Pure platinum rolled into extremely thin sheets. 2. A precious metal foil whose high fusing point makes it suitable as a matrix for various soldering procedures; also suitable to provide internal form of porcelain restorations during their fabrication.
- **tinfoil** 1. Tin rolled into extremely thin sheets. 2. A base metal foil used as a separating material, as between the cast and denture-base material during flasking and curing procedures.

forces of mastication The motive force created by the dynamic action of the muscles during the physiologic act of mastication.

forward protrusion (See *protrusion*)

framework The skeletal portion of a prosthesis (usually metal) around which and to which are attached the remaining portions of the prosthesis to produce the finished appliances (partial denture).

Frankfort plane A plane passing through the lowest point in the margin of the orbit (the orbitale) and the highest point in the margin of the auditory meatus (the tragion).

free gingival margin The edge or summit of the free gingival tissue; free gum margin.

free mandibular movements 1. Any mandibular movements made without tooth interference. 2. Any uninhibited movements of the mandible.

free-way space (Obj.) (See *interocclusal distance*)

fulcrum line An imaginary line around which a removable partial denture tends to rotate.

retentive f. l. 1. An imaginary line connecting the retentive points of clasp arms on retaining teeth adjacent to mucosa-borne denture bases. 2. An imaginary line connecting the retentive points of clasp arms, around which line the denture tends to rotate when subjected to forces such as the pull of sticky foods.

stabilizing f. l. An imaginary line connecting occlusal rests, around which line the denture tends to rotate under masticatory force.

full denture (Obj.), **complete denture** (See *denture*)

full denture prosthetics (Obj.), **complete denture prosthetics** (See *prosthetics*)

functional chew-in record (See also *milled-in paths*) 1. A record of the natural chewing movements of the mandible made on an occlusion rim by teeth or scribing studs. 2. A record of the movements of the mandible made upon the occluding surface of the opposing occlusion rim by teeth or scribing studs and produced by simulated chewing movements. 3. A record of certain lateral and protrusive movements of the mandible made upon the occlusal surface of an occlusion rim by teeth or studs on an opposing rim; produced during simulated movements of bruxism.

functional mandibular movements 1. All natural, proper, or characteristic movements of the mandible made during speech, mastication, yawning, swallowing, and other associated movements. 2. Movements of the mandible which occur during mastication, swallowing, speech, and yawning.

functional occlusion (See *occlusion*)

G

generated occlusal path (See *occlusal path, functional chew-in record*)

geriatrics That department of medicine or dentistry which treats all problems peculiar to advanced age and the aging, including the clinical problems of senescence and senility.

gerodontics, gerodontology (Obj.) 1. The study of the dentition in the aged or aging. 2. The branch of dentistry which deals with the dental condition of older people.

gingiva The fibrous tissue, covered by mucous membrane, which immediately surrounds a tooth and is continuous with its pericemental ligament.

gingival contour (See *gum contour*) The form of the denture-base or other material around the necks of the artificial teeth.

gingival retraction The displacement of the marginal gingivae away from a tooth.

gliding occlusion (See *occlusion*)

gnathion The lowest point on the median line of the mandible.

gnathodynamometer 1. An instrument for measuring the force exerted in closing the jaws. (Dor.) 2. An instrument used for measuring biting pressure.

Bimeter g. A gnathodynamometer equipped with a central-bearing point of adjustable height.

gold foil (See *foil*)

Gothic arch tracer (Obj.) (See *tracer, needle point*)

grinding-in 1. A term used to denote the act of correcting occlusal disharmonies by grinding the natural or artificial teeth. 2. The process of correcting errors in the centric and eccentric occlusion of the natural or artificial teeth.

guide plane 1. The plane developed in the occlusal surfaces of the occlusion rims (viz., to position the mandible in centric relation). 2. A plane which guides movement.

gum contour (See *gingival contour*) The form of structures adjacent to the teeth or of the flanges of dentures around the teeth.

gums (See *gingiva*) The fibrous and mucosa covering of the alveolar process or ridges.

H

hamular notch (See *pterygomaxillary notch*)

head of the condyle (Obj.) (See *condyle*)

heel (Obj.) (See *distal end*)

height of contour 1. A line encircling a tooth designating its greatest circumference. 2. The line encircling a tooth in a more or less horizontal plane and passing through the surface points of greatest radius. 3. The line encircling a tooth at its greatest bulge or diameter with respect to a selected path of insertion.

high lip line The greatest height to which the lip is raised in normal function or during the act of smiling broadly.

hinge axis (See *axis*)

hinge-bow (See *face-bow*)

hinge joint Ginglymus; a joint which allows motion around an axis.

hinge movement An opening or closing movement of the mandible on the hinge axis.

hinge position The orientation of parts in a manner permitting hinge movement between them.

condylar h. p. 1. The position of the condyles in the temporomandibular joints at which a hinge movement of the mandible is possible. 2. The maxillomandibular relation from which a consciously stimulated true hinge movement can be executed.

mandibular h. p. Any position of the mandible which exists when the condyles are so situated in the temporomandibular joints that opening or closing movements can be made on the hinge axis.

terminal h. p. 1. The mandibular hinge position from which further opening of the mandible would produce translatory rather than hinge movement. 2. The most retruded hinge position. The movement from this position, which is a conditioned movement, is always less than median full mouth opening. 3. The mandibular position existing when the condyles are in such positions in the temporomandibular joints that an opening by hinge movement is possible beyond the amplitude of rest position. The position of the condyles is the most retruded of which they are capable. The movement from this position, which is a conditioned movement, is always less than median full mouth opening.

horizontal overjet (See *horizontal overlap*)

horizontal overjut (See *horizontal overlap*)

horizontal overlap The projection of the upper anterior and/or posterior teeth beyond their antagonists in a horizontal direction.

Hydrocal (See *artificial stone*) A trade name for an artificial stone.

hydrocolloid The materials listed as colloid sols with water which are used in dentistry as elastic impression materials. Hydrocolloid can be reversible or irreversible.

irreversible h. (alginate) A hydrocolloid whose physical condition is changed by a chemical action which is not reversible.

reversible h. A hydrocolloid whose physical condition is changed by temperature. The material is made fluid by heat and becomes an elastic solid upon cooling.

hydrocolloid impression (See *impression*)

hygroscopic expansion Expansion due to the absorption of moisture.

hyperplasia The abnormal multiplication or increase in the number of normal cells in normal arrangement in a tissue. (Dor.)

hyperplastic tissue (See *tissue*)

hypertrophy The morbid enlargement or overgrowth of an organ or part due to an increase in size of its consituent cells. (Dor.)

hypoplasia Defective or incomplete development. (Dor.)

I

-ics Indicative of a science, practice, or treatment. Trend is from *-ia* to *-ics* in dentistry. *Orthodontia* became *orthodontics* about 1937. (Gr.) Adjective ending *-ikos,* in ancient Greek times used without the following noun to indicate a practice. Example: *ethics.* Ending *ics,* unlike *-ia,* can indicate only a practice, not a condition. To be preferred to *-ia.* (A.D.A.)

immediate denture (See *denture*)

immediate insertion denture (See *denture*)

implant A graft or insert set firmly or deeply into or onto the alveolar process prepared for its insertion.

implant denture A denture which receives its stability and retention from a substructure which is partially or wholly implanted under the soft tissues of the denture basal seat.

i. d. substructure The metal framework which is embedded beneath the soft tissues in contact with the bone for the purpose of supporting an implant denture superstructure.

i. d. superstructure The denture which is retained and stabilized by the implant denture substructure.

impression 1. An imprint or negative likeness. 2. The negative form of the teeth and/or other tissues of the oral cavity, made in a plastic material which becomes relatively hard or set while in contact with these tissues. An impression is made in order to reproduce a positive form or cast of the recorded tissues. (Impressions are classified according to the materials of which they are made as *reversible and irreversible hydrocolloid i., modeling plastic i., plaster i., wax i.*)

cleft palate i. An impression of a cleft palate.

complete denture i. 1. An impression of an edentulous arch made for the purpose of constructing a complete denture. 2. A negative registration of the entire denture-bearing, stabilizing area of either the maxillae or mandible. 3. A negative registration of the entire denture foundation and border seal areas present in the edentulous mouth.

final i. An impression which is used for making the master cast.

hydrocolloid i. Any impression made of a hydrocolloid material.

mandibular i., lower i. An impression of the mandibular jaw or dental structures.

maxillary i., upper i. An impression of the maxillary jaw or dental structures.

partial denture i. 1. A negative copy of the partially edentulous dental arch or area made for the purpose of constructing a partial denture. 2. An impression of a part or all of a partially edentulous arch made for the purpose of designing or constructing a partial denture. 3. An impression of a part or all of a partially edentulous arch.

preliminary i. An impression made for the purpose of diagnosis or the construction of a tray.

sectional i. An impression that is made in sections.

impression area That surface which is recorded in an impression.

impression material Any substance or combination of substances used for making a negative reproduction or impression.

impression surface (See *denture*)

impression technique A method and manner employed in making a negative likeness.

impression tray 1. A receptacle into which a suitable material is placed to make an impression. 2. A device which is used to carry, confine, and control an impression material for making an impression.

incisal guidance The influence on mandibular movements by the contacting surfaces of the mandibular and maxillary anterior teeth.

incisal guide, anterior guidance That part of an articulator which maintains the incisal guide angle.

incisal guide angle The angle formed with the horizontal plane by drawing a line in the sagittal plane between incisal edges of the maxillary and mandibular central incisors when the teeth are in centric occlusion.

incisal rest (See *rest*)

incisive papilla (See *papilla*)

index 1. A core or mold used to record or maintain the relative position of a tooth or teeth to one another and/or to a cast. 2. A guide, usually made of plaster, used to reposition teeth or casts or parts in order to reproduce their original position.

indirect retainer (See *retainer*)

indirect retention (See *retention*)

infrabulge (retention area of a tooth) That portion of the crown of a tooth gingival to the clasp guide or survey line, or height of contour.

initial contact 1. The first meeting of opposing teeth upon elevation of the mandible toward the maxillae. 2. The initial occlusal contact of opposing teeth when the jaw is closed.

injection molding The adaptation of a plastic material to the negative form of a closed mold by forcing the material into the mold through appropriate gateways. (See also *compression molding*)

insertion The intraoral placing of a dental prosthesis.

path of i. The direction in which a prosthesis is inserted upon and removed from the abutment teeth.

interalveolar space (Obj.) (See *interarch distance*)

interarch distance, interridge distance 1. The vertical distance between the maxillary and mandibular arches (alveolar or residual) under conditions of vertical dimension which must be specified. 2. The vertical distance between maxillary and mandibular ridges.

large i. d. A large distance between the maxillary and mandibular arches.

small i. d. A small distance between the maxillary and mandibular arches.

interceptive occlusal contact (Obj.) (See *deflective occlusal contact*) An initial contact of teeth which stops or deviates the normal movement of the mandible.

intercuspation The interdigitation of cusps of opposing teeth.

interdental The relationship between the proximal surfaces of the teeth of the same arch.

interdigitation (See *intercuspation*)

interfacial surface tension The tension or resistance to separation possessed by the film of liquid between two well-adapted surfaces, viz., the thin film of saliva between the denture base and the tissues.

intermaxillary relation (Obj.) (See *maxillomandibular relation*)

intermediary movement All movements between the extremes of mandibular excursions.

internal attachment (See *attachment*)

interocclusal Between the occlusal surfaces of opposing teeth.

interocclusal distance, interocclusal clearance, interocclusal gap, free-way space (Obj.), **interocclusal rest space** (Obj.) The distance between the occluding surfaces of the maxillary and mandibular teeth when the mandible is in its physiologic rest position. This can be determined by calculating the difference between the rest vertical dimension and the occlusal vertical dimension.

interocclusal record A record of the positional relation of the teeth or jaws to each other made on occlusal surfaces of occlusion rims or teeth in a plastic material which hardens, such as plaster of Paris, wax, or zinc oxide and eugenol paste.

centric i. r. A record of the centric jaw position (relation).

eccentric i. r. A record of a jaw relation other than centric relation.

lateral i. r. A record of a lateral eccentric jaw position.

protrusive i. r. A record of a protruded eccentric jaw position.

interocclusal rest space (Obj.) (See *interocclusal distance*)

interproximal space The space between adjacent teeth in a dental arch. It is divided into the embrasure occlusal to the contact point and the septal space gingival to the contact point.

interridge distance (See *interarch distance*)

intraoral Within the mouth. (Dor.)

invest To surround, envelop, or embed in an investment material.

investing The process of covering or enveloping wholly or in part an object such as a denture, tooth, wax form, crown, etc., with a refraction investment material before curing, soldering, or casting.

vacuum i. The investing of a pattern within a vacuum.

investment 1. Any material used in dentistry to invest an object. 2. The material used to enclose or surround a pattern of a dental restoration for casting or molding, or to maintain the relations of metal parts during soldering.

refractory i. An investment material which can withstand the high temperatures used in soldering or casting.

investment cast (Obj.), **refractory cast** (See *cast*)

irreversible hydrocolloid (See *hydrocolloid*)

isometric contraction (See *contraction, muscle*)

isotonic contraction (See *contraction, muscle*)

J

jaw A common name for either the maxillae or the mandible.

jaw malposition Any abnormal position of the mandible.

jaw movement 1. Movements of the lower jaw. 2. All changes in position of which the mandible is capable.

jaw relation Any relation of the mandible to the maxillae.

centric j. r. 1. The jaw relation when the condyles are in the most posterior unstrained position in the glenoid fossae from which lateral movement can be made at any given degree of jaw separation. 2. The most posterior relation of the mandible to the maxillae at the established vertical dimension. 3. The relation of the mandible to the maxillae when the condyles are in their most posterior position in the glenoid fossa from which unstrained lateral movements can be made at the occluding vertical dimension normal for the individual.

eccentric j. r. Any jaw relation other than centric relation.

median j. r. Any jaw relation when the mandible is in the median sagittal plane.

protrusive j. r. A jaw relation resulting from a protrusion of the mandible.

rest j. r. The habitual postural jaw relation when the patient is resting comfortably in an upright position and the condyles are in a neutral unstrained position in the glenoid fossae.

unstrained j. r. 1. The relation of the mandible to the skull when a state of balanced tonus exists between all the muscles involved. 2. Any jaw relation which is attained without undue or unnatural force and which causes no undue distortion of the tissues of the temporomandibular joints.

jaw repositioning The changing of any relative position of the mandible to the maxillae, usually by altering the occlusion of the natural or artificial teeth.

K

Kennedy bar (Obj.) (See *continuous bar retainer*)

kinematic face-bow (Obj.) (See *face-bow, hinge-bow*)

L

labial 1. Of or pertaining to a lip. 2. Toward a lip.

lateral A position either right or left from the midsagittal plane.

l. incisor The second incisor.

lateral checkbite (Obj.) (See *interocclusal record*)

lateral condylar inclination The direction of the lateral condyle path.

lateral condyle path The path of the condyle in the glenoid fossa when a lateral mandibular movement is made.

lateral movement Movement of the mandible to the side.

lateral protrusion (See *protrusion*)

line of occlusion The alignment of the occluding surfaces of the teeth in the horizontal plane. (See *occlusal plane*).

lingual 1. Pertaining to the tongue. 2. Next to, or toward, the tongue. (D. & D.)

lingual plate A major partial denture connector formed as a lingual bar extended to cover the cingula of the lower anterior teeth.

lingual rest A metallic extension onto the lingual surface of a tooth to provide support or indirect retention for a removable partial denture.

low lip line 1. The lowest position of the lower lip during the act of smiling or voluntary retraction. 2. The lowest position of the upper lip at rest.

lower impression (See *impression, mandibular*)

lower ridge slope 1. The slope of the mandibular residual ridge in the second and third molar region as seen from the buccal side.

M

major connector (See *connector*)

malocclusion 1. Any deviation from a physiologically acceptable contact of opposing dentitions. 2. Any deviation from a normal occlusion.

mandible The lower jawbone.

mandibular axis (Obj.), **hinge axis** (See *axis*)

mandibular glide The side-to-side, protrusive, and intermediate movement of the mandible occurring when the teeth or other occluding surfaces are in contact.

mandibular hinge position (See *hinge position*)

mandibular impression (See *impression*)

mandibular movement Any movement of the lower jaw.

mandibular protraction A type of facial anomaly in which the gnathion lies anterior to the orbital plane.

mandibular retraction A type of facial anomaly in which the gnathion lies posterior to the orbital plane.

masking An opaque covering to camouflage the metal parts of a prosthesis.

mastication The process of chewing food for swallowing and digestion.

components of m. The various jaw movements which are made during the act of mastication as determined by the neuromuscular system, the temporomandibular articulations, the teeth, and the food being chewed. The components of mastication may be separated (for purposes of analysis or description) into *opening components of mastication, closing components of mastication, left lateral components of mastication, right lateral components of mastication,* and *anteroposterior components of mastication.*

masticating cycles The patterns of mandibular movements formed during the chewing of food.

masticatory apparatus (Obj.) (See *stomatognathic system*)

masticatory force The force applied by the muscles of mastication during mastication.

masticatory movements 1. Chewing movements. 2. Mandibular movements used for chewing food.

masticatory system 1. The organs and structures primarily functioning in mastication. They are: jaws, teeth with their supporting structures, temporomandibular articulation, mandibular musculature, tongue, lips, cheeks, and oral mucosa. (A.D.A.)

maxillary impression (See *impression*)

maxillary protraction A type of facial anomaly in which the subnasion lies anterior to the orbital plane.

maxillofacial Pertaining to the jaws and the face. (Dor.)

maxillomandibular record, maxillomandibular registration 1. A record of the relation of the mandible to the maxillae. 2. The act of recording the relation of the mandible to the maxillae.

maxillomandibular relation Any one of the many relations of the mandible to the maxillae, such as centric maxillomandibular relation, eccentric maxillomandibular relation, etc.

mean foundation plane The mean of the inclination of the denture-supporting tissues. Since the tissues constituting the denture foundation are irregular in form and consistency, and since there is only one direction from which force may be applied if it is to comply with the law of statics requiring "force at right angle to support," the mean foundation plane forms a right angle with the most favorable direction of force.

mechanically balanced occlusion (See *balanced occlusion*)

median jaw relation (See *jaw relation*)

median line 1. The intersection of the midsagittal plane with the maxillary and mandibular dental arches. 2. The center line dividing the central body surface into right and left.

median mandibular point A point on the anteroposterior center of the mandibular ridge in the median sagittal plane.

median relation (Obj.) (See *centric relation*)

median retruded relation (Obj.) (See *centric relation*)

mesial 1. Toward or situated in the middle, as the median line of the body or the center of the dental arch. 2. Situated in the middle; median, toward the middle line of the body or toward the center line of the dental arch. (Dor.)

metal base 1. The basal surface of a denture, constructed of metal, to which the teeth are attached. 2. The metal plate used for the support or attachment of artificial teeth.

metal insert teeth (See *teeth*)

metal saddle (Obj.) (See *metal base*)

milled-in paths, milled-in curves (See also *functional chew-in record*) 1. Contours carved by various mandibular movements into the occluding surface of an occlusion rim, by teeth or studs placed in the opposing occlusion rim. The curves or contours may be carved into wax, modeling plastic, or plaster of Paris. 2. Occlusal curves developed by masticatory or gliding movements of occlusion rims which are composed of materials including abrasives.

milling-in The procedure of refining or perfecting the occlusion of teeth by the use of abrasives between their occluding surfaces while the dentures are rubbed together in the mouth or on the articulator. (See also *selective grinding*)

minor connector (See *connector*)

model (Obj.) (See *cast*)

modeling plastic, modeling composition, modeling compound (Obj.) A thermoplastic material usually composed of gum damar and prepared chalk, used especially for making dental impressions.

modiolus A point near the corner of the mouth where several muscles of facial expression converge.

mold 1. A form in which an object is cast or shaped. 2. The term used to specify the shape of an artificial tooth or teeth.

Monson curve (Obj.) (See *compensating curve*) The curve of occlusion in which each cusp and incisal edge touches or conforms to a segment of the surface of a sphere eight inches in diameter with its center in the region of the glabella.

mounting The laboratory procedure of attaching the maxillary and/or mandibular cast to an articulator.

mouth rehabilitation Restoration of the form and function of the masticatory apparatus to as nearly a normal condition as possible.

mucobuccal fold The line of flexure of the mucous membrane as it passes from the mandible or maxillae to the cheek.

mucositis Inflammation of a mucous membrane surface.

mucostatic 1. The normal, relaxed condition of mucosal tissues covering the jaws. 2. Arresting the secretion of mucus.

muscle hypertenseness Increased muscular tension which is not easily released but which does not prevent normal lengthening of the muscle. Hypertenseness is found in patients with general nervousness.

muscle relaxant A drug which specifically aids in lessening of muscle tension.

muscle spasm Increased muscular tension and shortness which cannot be released voluntarily and which prevent lengthening of the muscles involved. Spasm is due to pain stimuli to the lower motor neuron.

muscle spasticity Increased muscular tension of antagonists, preventing normal movement, caused by an inability to relax (a loss of reciprocal inhibition) due to a lesion of the upper motor neuron.

muscle trimming (Obj.), **border molding** (See *border*)

mushbite (Obj.) (See *maxillomandibular record*) A maxillomandibular record made by introducing a mass of soft wax into the patient's mouth and instructing the patient to bite into it to the desired degree. Not a generally accepted procedure.

mylohyoid region The region on the lingual surface of the mandible marked by the mylohyoid ridge and the attachment of the mylohyoid muscle.

N

nasion The point at which the nasofrontal suture is bisected by the midsagittal plane.

natural dentition (See *dentition*)

needle point tracer (See *tracer*)

neutral zone The potential space between the lips and cheeks on one side and the tongue on the other. Natural or artificial teeth in this zone are subject to equal and opposite forces from the surrounding musculature.

nonanatomic teeth (See *teeth*)

O

obturator 1. A prosthesis used to close a congenital or acquired opening in the palate.

occlude 1. To bring together; to shut. 2. To bring or close the mandibular teeth up into contact with the maxillary teeth.

occluder (Obj.) (See *articulator*) A name given to some articulators.

occluding centric relation record A registration of centric relation made at the established occlusal vertical dimension.

occluding frame (Obj.) (See *articulator*) A name given to a device for relating casts to each other for the purpose of arranging teeth.

occluding relation The jaw relation at which the opposing teeth occlude.

occlusal 1. Pertaining to the contacting surfaces of opposing occlusal units (teeth or occlusion rims). 2. Pertaining to the masticating surfaces of the posterior teeth.

occlusal analysis A study of the relations of the occlusal surfaces of opposing teeth.

occlusal balance 1. A condition in which there are simultaneous contacts of the occluding units on both sides of the opposing dental arches. 2. A condition in which equilibrium of the various components of mastication exists.

occlusal correction 1. The correction of malocclusion, by whatever means is employed. 2. The elimination of disharmony of occlusal contacts.

occlusal curvature (See *curve of occlusion*)

occlusal disharmony (See *deflective occlusal contact, interceptive occlusal contact*) 1. Contacts of opposing occlusal surfaces of teeth which are not in harmony with other tooth contacts and with the anatomic and physiologic control of the mandible. 2. Occlusions which do not coincide with their respective jaw relations.

occlusal equilibration (See *equilibration*)

occlusal force The resultant of muscular force applied on opposing teeth.

occlusal form The form of the occlusal surface of a tooth or of a row of teeth.

occlusal harmony Occlusions which are in harmony with similar jaw relations, e.g., centric occlusion in harmony with centric jaw relation.

functional o.h. Such occlusal relationship of opposing teeth in all functional ranges and movements as will provide the greatest masticatory efficiency without causing undue strain or trauma upon the supporting tissues.

occlusal path 1. A gliding occlusal contact. 2. The path of movement of an occlusal surface.

generated o.p. A registration of the paths of movement of the occlusal surfaces of mandibular teeth on a plastic or abrasive surface attached to the maxillary arch.

occlusal pattern The form or design of the occluding surfaces of a tooth or teeth. These forms may be based upon natural or modified anatomic or nonanatomic concepts of teeth.

occlusal pivot An elevation on the occlusal surface about which the mandible may rotate.

occlusal plane, plane of occlusion An imaginary surface which is related anatomically to the cranium and which theoretically touches the incisal edges of the incisors and the tips

of the occluding surfaces of the posterior teeth. It is not a plane in the true sense of the word but represents the mean of the curvature of the surface. (See *curve of occlusion*)

occlusal position The relationship of the mandible and maxillae when the jaw is closed and the teeth are in contact. This position may or may not coincide with centric occlusion.

occlusal pressure Any force exerted upon the occlusal surfaces of teeth.

occlusal rest (See *rest*)

occlusal rest bar A minor connector used to attach an occlusal rest to a major part of a removable partial denture.

occlusal rim (Obj.) (See *occlusion rim*)

occlusal system, occlusal scheme The form or design and arrangement of the occlusal and incisal units of a dentition or the teeth on a denture.

occlusal stop (Obj.), **occlusal rest** (See *rest*)

occlusal surface (See *denture*)

occlusal vertical dimension (See *vertical dimension*)

occlusal wear Attritional loss of substance on opposing occlusal units or surfaces. (See *abrasion*)

occlusion 1. Any contact between the incising or masticating surfaces of the upper and lower teeth. 2. The relationship between the occlusal surfaces of the maxillary and mandibular teeth when they are in contact.

balanced o. 1. An occlusion of the teeth which presents a harmonious relation of the occluding surfaces in centric and eccentric positions within the functional range. 2. The simultaneous contacting of the upper and lower teeth on the right and left and in the anterior and posterior occlusal areas. This occlusion is developed to prevent a tipping or rotating of the denture bases in relation to the supporting structures. It is thought of primarily in the mouth, but it is arranged and may be observed on articulators. 3. The simultaneous contacting of the upper and lower teeth on the right and left and in the anterior and posterior occlusal areas in centric or any eccentric position. This occlusion is developed to prevent a tipping or rotating of the denture bases in relation to the supporting structures. It is thought of primarily in the mouth, but it is arranged and may be observed on articulators.

centric o. 1. The relation of opposing occlusal surfaces which provides the maximum planned contact and/or intercuspation. 2. The occlusion of the teeth when the mandible is in centric relation to the maxillae.

eccentric o. Any occlusion other than centric occlusion.

functional o. 1. Any tooth contacts made within the functional range of the opposing tooth surfaces. 2. Occlusion which occurs during function. 3. Functional occlusion directs attention specifically to performance, differentiated from structure and appearance. It should be used with modifying terms to indicate the degree of function that occlusion achieves. (A.D.A.)

gliding o. Used in the sense of designating contacts of teeth in motion. (A substitute for the term *articulation*.)

pathogenic o. An occlusal relationship capable of producing pathologic changes in the supporting tissues.

physiologic o. Occlusion in harmony with functions of the masticatory system.

protrusive o. An occlusion of the teeth when the mandible is protruded forward from centric position.

traumatic o. 1. An occlusion which results in overstrain and injury to teeth, periodontal tissues, or to the residual ridge. 2. An occlusion of the teeth which is injurious to oral structures.

traumatogenic o. 1. A malocclusion capable of producing injury to the teeth or associated tissues. 2. An occlusion which is capable of producing injury to the teeth, periodontal membrane, or residual ridge.

occlusion rim, record rim Occluding surfaces built on temporary or permanent denture bases for the purpose of making maxillomandibular relation records and for arranging teeth.

open bite (Obj.), **large interarch distance** (See *interarch distance*)

opening movement Movement of the mandible executed during jaw separation.
organ of mastication (Obj.) (See *stomatognathic system*)
overbite (Obj.) (See *vertical overlap*)
overclosure (See *reduced interarch distance*)
overjet, overjut (See *horizontal overlap*)

P

packing The act of filling a mold.
denture p. Filling and compressing a denture-base material into a mold in a flask.
palatal seal (Obj.) (See *posterior palatal seal*)
papilla Any small, nipple-shaped elevation. (Dor.)
incisive p. The elevation of soft tissue covering the foramen of the incisive or nasopalatine canal.
parallel attachment (See *attachment*)
parallelometer 1. An instrument for measuring relative parallelism. 2. An apparatus used for making a part or an object parallel with some other part or object, or for paralleling attachments and abutments for fixed partial dentures or precision attachments for removable partial dentures.
partial denture (See *denture*)
partial denture construction The science and technique of designing and construcing partial dentures.
partial denture impression (See *impression*)
partial denture prosthesis (See *prosthesis*)
partial denture retention (See *retention*)
Passavant's pad, bar, ridge 1. The bulging "cross roll" of the posterior pharyngeal wall produced by the upper portion of the superior pharyngeal constrictor during the act of swallowing or vocal effort. 2. A ridge of erectile tissue on the posterior wall of the pharynx.
passivity The quality or condition of inactivity or rest assumed by the teeth, tissues, and denture when a removable partial denture is in place but not under masticatory pressure.
path of insertion (See *insertion*)
pathogenic occlusion (See *occlusion*)
pathology The branch of medical science which deals with disease in all its relations, especially with its nature and the functional and material changes caused by it.
pathosis A disease entity.
pattern A form which is used to make a mold, as for an inlay or partial denture framework.
pear-shaped area (Obj.) (See *retromolar pad*)
peripheral seal (Obj.), **border seal** (See *border*)
periphery (Obj.), **denture border** (See *denture*)
phonetic values The character of quality of vocal sounds.
phonetics The science of sounds used in speech.
physiologic occlusion (See *occlusion*)
physiologic rest position (See *rest relation*) The habitual postural position of the mandible when the patient is resting comfortably in the upright position and the condyles are in a neutral unstrained position in the glenoid fossae.
physiologically balanced occlusion (See *balanced occlusion*)
pickling The process of cleansing metallic surfaces of the product of oxidation and other impurities by immersion in acid.
pier (Obj.) (See *abutment*)
plane of occlusion (See *occlusal plane*)
planes of reference Planes which act as a guide to the location of other planes.
plaster A colloquial term applied to dental plaster of Paris.
plaster of Paris 1. Calcined calcium sulfate in the form of a fine powder. About one-half of the water of crystallization has been driven off, and when water is added it solidifies to a

porous mass that is used extensively in dentistry and in surgery. (Dor.) 2. The hemihydrate of calcium sulfate, which, when mixed with water, forms a paste which subsequently sets.

plastic base A denture or record base made of a plastic material.

plastic teeth (See *teeth*)

platinum foil (See *foil*)

Pleasure curve (See *curve*)

polished surface (See *denture*)

polishing v. Making smooth and glossy, usually by friction; giving luster to. n. The act or process of making a denture or casting smooth and glossy.

polymerization The forming of a compound from several single molecules of the same substance, the molecular weight of the new compound being a multiple equal to the number of single molecules which have been combined. (Gould)

pontic An artificial tooth on a fixed partial denture. It replaces the lost natural tooth, restores its functions, and usually occupies the space previously occupied by the natural crown.

post dam (Obj.) (See *posterior palatal seal*)

post dam area (Obj.) (See *posterior palatal seal area*)

posterior palatal seal The seal at the posterior border of a denture.

posterior palatal seal area The soft tissues along the junction of the hard and soft palates on which pressure within the physiologic limits of the tissues can be applied by a denture to aid in the retention of the denture.

pospalatal seal (Obj.) (See *posterior palatal seal*)

pospalatal seal area (Obj.) (See *posterior palatal seal area*)

postsurgical prosthesis (See *prosthesis*)

precision rest (See *rest*)

pre-extraction cast (Obj.) (See *cast*)

pre-extraction records (See *preoperative records*)

preliminary impression (See *impression*)

premature contact (Obj.) (See *deflective occlusal contact, interceptive occlusal contact*)

prematurity (Obj.) (See *deflective occlusal contact, interceptive occlusal contact*)

preoperative cast (Obj.), **study cast** (See *cast*)

preoperative records, pre-extraction records Any record or records made for the purpose of study or treatment planning.

pressure area An area of excessive displacement of tissue.

primary impression (Obj.), **preliminary impression** (See *impression*)

process 1. (anatomy) A marked prominence or projection of a bone. 2. (dental) A series of operations which convert a wax pattern, such as that of a denture base, into a solid denture base of another material. (Obj.) (See *denture curing*)

profile An outline or contour, especially one representing a side view of a human head.

profile record A registration or record of the profile of a patient.

prognosis A forecast as to the probable result of an attack of disease; the prospect as to recovery from a disease afforded by the nature and symptoms of the case. In denture service, an opinion of the prospects for success of a restoration.

- **denture p.** An opinion or judgment, given in advance of treatment, of the prospects for success in the construction and usefulness of dentures.

prosthesis The replacement of an absent part of the human body by an artificial part.

- **cleft palate p.** An appliance to correct congenital acquired defects in the palate and related structures if they are involved.
- **complete denture p.** (See *denture*)
- **dental p.** An artificial replacement of one or more teeth and/or associated structures.
- **partial denture p.** (See *denture*)
- **postsurgical p.** An artificial replacement of a missing part or parts after operation.
- **surgical p.** An appliance prepared to assist in surgical procedures.
- **temporary p.** A fixed or removable restoration replacement of which with a more permanent appliance is planned within a short period of time.

prosthetic dentistry (See *prosthodontics*)
prosthetic restoration (Obj.) (See *prosthesis*)
prosthetic speech aid (See *speech aid*)
prosthetics The art and science of supplying missing parts of the human body.
complete denture p. 1. The restoration of the natural teeth in the arch and their associated parts by artificial replacements. 2. The art and science of the restoration of an edentulous mouth.
prosthetist An individual involved in the construction of an artificial replacement for any part of the human body.
prosthodontia (Obj.) (See *prosthodontics*)
prosthodontics, prosthetic dentistry 1. That branch of dental art and science pertaining to the restoration and maintenance of oral function by the replacement of missing teeth and structures by artificial devices. 2. The science and art of providing suitable substitutes for the coronal portions of teeth, or for one or more lost or missing natural teeth and their associated parts, in order that impaired function, appearance, comfort, and health of the patient may be restored. (A.D.A.)
prosthodontist A dentist engaged in the practice of prosthodontics.
protrusion A position of the mandible forward or lateral from centric position.
forward p. A protrusion forward from centric position.
lateral p. A protrusion with a lateral component.
protrusive checkbite (Obj.) (See *protrusive record, checkbite*)
protrusive occlusion (See *occlusion*)
protrusive record A registration of a forward position of the mandible with reference to the maxillae.
protrusive relation The relation of the mandible to the maxillae when the lower jaw is thrust forward.
psychosomatic Pertaining to the mind-body relationship; having bodily symptoms of a psychic, emotional, or mental origin. (Dor.)
p. dentistry Dentistry which concerns itself with the mind-body relationship.
pterygomaxillary notch, hamular notch The notch or fissure formed at the junction of the maxilla and the hamular or pterygoid process of the sphenoid bone

Q

quick cure resin (Obj.), **autopolymer resin** (See *resin*)

R

radiogram (Obj.), **radiograph** (Obj.) (See *roentgenogram*)
rebase A process of refitting a denture by the replacement of the denture-base material without changing the occlusal relations of the teeth.
reciprocal arm A clasp arm or other extension used on a removable partial denture to oppose the action of some other part or parts of the appliance.
reciprocation The means by which one part of an appliance is made to counter the effect created by another part.
record base (See *baseplate*)
record rim (See *occlusion rim*)
reduced interarch distance, overclosure (Obj.) An occluding vertical dimension which results in an excessive interocclusal distance when the mandible is in rest position and in a reduced interridge distance when the teeth are in contact.
refractory cast (See *cast*)
refractory investment (See *investment*)
registration The record of desired jaw relations in order to transfer these relations to an articulator.

relief The reduction or elimination of pressure from a specific area under a denture base.

r. area The portion of the surface of the mouth upon which pressures are reduced or eliminated.

r. chamber A recess in the impression surface of a denture to reduce or eliminate pressure from that specific area of the mouth.

reline To resurface the tissue side of a denture with new base material to make it fit more accurately.

removable bridge (Obj.), **removable partial denture** (See *denture*)

removable partial denture (See *denture*)

residual ridge (See *ridge*)

resin A broad term used to indicate organic substances usually translucent or transparent, soluble in ether, etc., but not in water. They are named according to their chemical composition, physical structure, and means for activation or curing. Examples, *acrylic r., autopolymer r., synthetic r., styrene r., vinyl r.*

acrylic r. A general term applied to a resinous material of the various esters of acrylic acid. It is used as a denture-base material and is used for trays and other dental restorations.

a. r. base A plastic denture base made of an acrylic resin.

a. r. denture A denture made of acrylic resin.

a. r. tooth A tooth made of acrylic resin.

a. r. tray A tray made of acrylic resin.

autopolymer r., activated r., cold-curing r., self-curing r. Any resin which can be polymerized by an activator and a catalyst without use of external heat.

copolymer r. A synthetic resin which is the product of the concurrent and joint polymerization of two or more different monomers or polymers.

resorption 1. A loss of substance by physiologic or pathologic means. 2. The reduction of the volume and size of the alveolar portion of the mandible or maxillae.

rest An extension from a prosthesis that affords vertical support for a restoration.

incisal r. 1. The portion of the tooth selected and prepared to receive an occlusal or an incisal rest. 2. A metallic extension at the incisal angle of an anterior tooth to supply tooth support for the removable partial denture and to maintain the clasp in its proper position on the tooth.

lingual r. A metallic extension onto the lingual surface of an anterior tooth to provide support or indirect retention for a removable partial denture.

occlusal r. 1. A rest placed on the occlusal surface of a posterior tooth. 2. A metallic extension on the occlusal surface of a tooth to provide support for a removable partial denture.

precision r. A rest consisting of closely interlocking parts.

rest area, rest seat 1. The portion of the tooth selected and prepared to receive an occlusal, incisal, or lingual rest. 2. The portion of tooth structure or of a restoration in a tooth prepared so it is spoon shaped on posterior teeth and V shaped or hook shaped on some anterior teeth, into which seats the metallic occlusal or incisal rest of a partial denture.

rest occlusion (Obj.), **rest bite** (Obj.) (See *physiologic rest position*) These are contradictory terms which should not be used.

rest position (See *physiologic rest position*) The position of the mandible when the jaws are in rest relation. (See also *rest relation*)

rest relation The postural relation of the mandible to the maxillae when the patient is resting comfortably in the upright position and the condyles are in a neutral unstrained position in the glenoid fossae.

rest vertical dimension (See *vertical dimension*)

restoration, prosthetic restoration, appliance Broad terms applied to any inlay, crown, bridge, partial denture, or complete denture which restores or replaces loss of tooth structure, teeth, or oral tissues. (A.D.A.)

retainer Any form of attachment applied directly to an abutment tooth used for the fixation of the prosthetic restoration.

continuous bar r. 1. A metal bar, usually resting on lingual surfaces of teeth, to aid in their stabilization and to act as indirect retainers. 2. A metal bar which contacts lingual surfaces of anterior teeth and aids in the retention of a distal extension partial denture.

direct r. A clasp or attachment applied to an abutment tooth for the purpose of maintaining a removable appliance in position.

indirect r. A part of a removable partial denture which assists the direct retainers in preventing displacement of free end denture bases by functioning through lever action on the opposite side of the fulcrum line.

retention That quality inherent in the denture which resists the force of gravity, the adhesiveness of foods, and the forces associated with the opening of the jaws.

direct r. Retention obtained in a removable partial denture by the use of attachments or clasps which resist their removal from the abutment teeth.

indirect r. Retention obtained in a removable partial denture through the use of indirect retainers. (See *indirect retainer*)

retention arm An extension which is part of a removable partial denture and is utilized to aid in the fixation of the appliance; a part of a clasp.

retention of denture The resistance of a denture to dislodgment.

retentive arm A flexible segment of a removable partial denture that engages an undercut on an abutment and is designed to retain the denture.

retromolar pad A mass of tissue, frequently pear shaped, which is located at the distal termination of the mandibular residual ridge.

retrusion 1. Retraction of the mandible from any given point. 2. The backward movement of the mandible.

reverse curve (See *curve*)

reversible hydrocolloid (See *hydrocolloid*)

ridge The ridge is the remainder of the alveolar process after the teeth are removed.

alveolar r. The bony ridge (alveolar process) of the maxillae or mandible which contains the alveoli (sockets of the teeth).

center of r. The buccolingual midline of the residual ridge.

crest of r. The highest continuous surface of the ridge, but not necessarily the center of the ridge. The top of a residual or alveolar ridge.

residual r. The portion of the alveolar ridge which remains after the alveoli have disappeared from the alveolar process after the teeth have been removed.

ridge relation The positional relation of the mandibular ridge to the maxillary ridge.

Roach clasp (Obj.), **bar clasp** (See *clasp*)

roentgenogram, roentgenograph The shadow image of radiopaque anatomic structures recorded upon film sensitized to roentgen rays.

roentgenographic interpretation An opinion formed from the study of a roentgenograph.

rotation center A point or line around which all other points in a body move.

rugae The irregular ridges in the mucous membrane covering the anterior part of the hard palate.

rugae area, rugae zone The portion of the mouth in which rugae are found.

S

saddle (Obj.), **denture base** (See *denture*)

scribe To write, trace, or mark by making a line or lines with a pointed instrument.

sea gull tracer (Obj.) (See *tracer, needle point*)

sectional impression (See *impression*)

segment Any of the parts into which a body naturally separates or is divided, either actually or by an imaginary line.

selective grinding 1. The modification of the occlusal forms of teeth by grinding according to a plan. 2. The modification of the occlusal forms of teeth by grinding at selected places marked by spots made by articulating paper.

separating medium 1. Any coating used upon a surface which serves to prevent another surface from adhering to the first. 2. A material usually coated on impressions to facilitate removal of the cast.

setting expansion The dimensional increase which occurs concurrently with the hardening of various materials, such as plaster of Paris.

setup The arrangement of teeth on a trial denture base.

shade selection, tooth color selection The determination of the color (hue, brilliance, saturation) of an artificial tooth or set of teeth for a given patient.

shellac bases Certain resinous materials adapted to maxillary or mandibular casts to form baseplates.

single denture construction The making of one upper or lower denture as distinguished from a set of complete dentures.

slotted attachment (Obj.) (See *attachment*)

snap impression (Obj.), **preliminary impression** (See *impression*)

solder 1. A fusible alloy of metals used to unite the edges or surfaces of two pieces of metal. (Dor.) 2. The act of uniting two pieces of metal by the proper alloy of metals.

spatulate To manipulate or mix with a spatula.

spatulation The manipulation of material with a spatula in order to mix it into a homogeneous mass.

speech aid Therapy or appliance to improve speech.

prosthetic s. a. An appliance used to close a cleft in the hard or soft palate or both, or to replace lost tissue necessary for the production of good speech.

spherical form of occlusion An arrangement of teeth which places their occlusal surfaces on the surface of an imaginary sphere (usually eight inches in diameter) with its center above the level of the teeth.

splint A rigid or flexible appliance for the fixation of displaced or movable parts.

splinting (of abutments) The joining of two or more teeth into a rigid unit by means of fixed restorations.

split cast method 1. A procedure for placing indexed casts on an articulator to facilitate their removal and replacement on the instrument. 2. The procedure of checking the ability of an articulator to receive or be adjusted to a maxillomandibular relation record.

split cast mounting 1. A cast with key grooves on its base, mounted on an articulator for the purpose of easy removal and accurate replacement. Split remounting metal plates may be used instead of grooves in casts. 2. A means for testing the accuracy of articulator adjustment.

sprue Wax or metal used to form the aperture or apertures for molten metal to flow into a mold to make a casting; also the metal which later fills the sprue hole or holes.

sprue former The base to which the sprue is attached while the wax pattern is being invested in a refractory investment in a casting flask.

stability 1. The quality of a denture to be firm, steady, constant, and not subject to change of position when forces are applied. 2. The quality of a denture to resist displacement by functional stresses.

stabilization The seating or fixation of a fixed or removable denture so that it will not tilt or be displaced under pressure.

stabilized baseplate (See *baseplate*)

staining Modification of the color of the tooth or denture base.

static relations Relationship between two parts that are not in motion.

stomatognathic system The combination of all the structures involved in speech, and the receiving, mastication, and deglutition of food.

stomatology The study of the structures, functions, and diseases of the mouth.

stone die A positive likeness in artificial stone used in the fabrication of a restoration.

stress-bearing area 1. The portion of the mouth capable of providing support for a denture. 2. Surfaces of oral structures which resist forces, strains, or pressures brought upon them during function. (See *denture foundation, basal seat*)

stress breaker A device which relieves the abutment teeth of all or part of the occlusal forces.

study cast (See *cast*)

stylus tracer (See *tracer, needle point*)

sublingual Pertaining to the region or structures located beneath the tongue.

sublingual crescent The crescent-shaped area on the floor of the mouth formed by the lingual wall of the mandible and the adjacent part of the floor of the mouth.

sublingual fold The crescent-shaped area on the floor of the mouth following the inner wall of the mandible and tapering toward the molar regions. It is formed by the sublingual gland and submaxillary duct.

subocclusal surface A portion of the occlusal surface of a tooth which is below the level of the occluding portion of the tooth.

substructure (See *implant denture*)

suction chamber (Obj.), **relief chamber** (Obj.) (See *relief*)

suction cup (Obsolete) A thin rubber disc usually with a hole in its center to fit over a button which is larger in diameter than the hole. This causes the disc to assume a cup shape. When applied on the tissue surface of a denture the cup attaches itself to the mucous membrane by suction.

sulcus 1. A furrow, trench, or groove, as on the surface of the brain or in folds of mucous membrane. 2. A groove or depression on the surface of a tooth. 3. A groove in a portion of the oral cavity.

superstructure (See *implant denture*)

support Resistance to vertical components of masticatory force.

supporting area 1. The surface of the mouth available for support of a denture. 2. Those areas of the maxillary and mandibular edentulous ridges which are considered best suited to carry the forces of mastication when the dentures are in function.

suprabulge That portion of the crown of a tooth which converges toward the occlusal surface of the tooth.

surgical prosthesis (See *prosthesis*)

surgical template (See *template*)

survey line 1. The line indicating the height of contour of a tooth after the cast has been positioned according to the chosen path of insertion. 2. A line produced on a cast of a tooth by a surveyor scriber. It marks the greatest height of contour in relation to the chosen path of insertion of the restoration. 3. A line drawn on a tooth or teeth by means of a surveyor for the purpose of determining the positions of the various parts of a clasp or clasps.

surveying The procedure of locating and delineating the contour and position of the abutment teeth and associated structures before designing a removable partial denture.

swage To shape metal by hammering or adapting it onto a die.

swallowing threshold 1. The moment the act of swallowing begins after the mastication of food. 2. The critical moment of reflex action initiated by minimum stimulation, prior to the act of deglutition.

T

technique, technic (Obj.) 1. A detailed method or procedure used in the preparation and construction of a prosthetic appliance. 2. The skill used in the execution of a procedure.

teeth (pl. of tooth) Organs of mastication.

- **anatomic t.** 1. Artificial teeth which more or less duplicate the anatomic forms of natural teeth. 2. Teeth which have notably pointed or rounded eminences on the masticating surfaces, and are designed to occlude in the sulci of the teeth of the opposite denture or dentition.
- **artificial t.** Teeth fabricated for use as substitutes for the natural teeth.
- **cross-bite t.** Posterior teeth designed to permit the modified buccal cusps of the upper teeth to be positioned in the fossae of the lower teeth.

cuspless t. Teeth designed without cuspal prominences on the masticatory surfaces.

metal insert t. Prosthetic teeth containing metal cutting surfaces in the occlusal surface.

nonanatomic t. 1. Teeth whose occlusal surfaces are not based on anatomic forms. 2. Artificial teeth so designed that the occlusal surfaces are not copied from natural forms, but rather are given forms which in the opinion of the designer seem more nearly to fulfill the requirements of mastication, tissue tolerance, etc.

plastic t. Artificial teeth constructed of synthetic resins.

set of t. Usually refers to a full complement of maxillary and/or mandibular artificial teeth, as they are carded by the manufacturer.

tube t. Artificial teeth constructed with a vertical, cylindric aperture extending from the center of the base up into the body of the tooth into which a pin may be placed or cast for the attachment of the tooth to a denture base.

zero degree t. Prosthetic teeth having no cusp angles in relation to the horizontal.

template A pattern or mold; a curved or flat plate utilized as an aid in setting teeth.

surgical t. A thin transparent resin base shaped to duplicate the form of the impression surface of an immediate denture, and used as a guide for surgically shaping the alveolar process to fit an immediate denture.

temporomandibular articulation, temporomandibular joint (See *articulation)*

tension The state of being stretched, strained, or extended.

terminal hinge position (See *hinge position*)

terminal jaw relation record A record of the relationship of the mandible to the maxillae made at the vertical relation of occlusion and at the centric position.

thermal expansion Expansion caused by heat.

thermoplastic A material which can be made soft by the application of heat and which hardens upon cooling.

three dimensional record (3D record) A maxillomandibular record made at the occluding relation.

tinfoil (See *foil*)

tinted denture base A denture base which simulates the coloring and shading of natural oral tissues.

tissue 1. The various cellular combinations which make up the body. 2. An aggregation of similarly specialized cells united in the performance of a particular function. (Dor.)

hyperplastic t. Excessively movable tissue about the maxillae or mandible.

tissue-bearing area (Obj.) (See *denture foundation*)

tissue displaceability 1. The quality of oral tissues which permits them to be placed in other than their relaxed position. 2. The degree to which tissues permit displacement.

tissue displacement The change in the form or position of tissues as the result of pressure.

tissue molding (Obj.), **border molding** (See *border*)

tissue reaction The response of tissues to altered conditions.

tissue registration 1. The accurate registration of the shape of tissues under any condition by means of a suitable material. 2. An impression.

tissue trimming (Obj.), **border molding** (See *border*)

tooth arrangement 1. The placement of teeth on a denture with definite objectives in mind. 2. The setting of teeth on temporary bases.

anterior t. a. The arrangement of anterior teeth for esthetic or phonetic effects.

tooth-borne A term used to describe a prosthesis or part of a prosthesis which depends entirely upon the abutment teeth for support.

tooth-borne base The denture base restoring an edentulous area which has abutment teeth at each end for support. The tissue which it covers is not used for support.

tooth form The characteristics of the curves, lines, angles, and contours of various teeth which permits their identification and differentiation.

anterior t. f. The outline form and other contours of an anterior tooth.

posterior t. f. The distinguishing contours of the occlusal surface of the various posterior teeth.

tooth selection The selection of a tooth or teeth in shape, size, and color to harmonize with the individual characteristics of a patient.

torque A rotatory force applied to a denture base.

tracer 1. A mechanical device used to trace a pattern of mandibular movements. 2. A mechanical device with a marking point, attached to one jaw and a graph plate or tracing plate attached to the other jaw. It is used to record the direction and extent of movements of the mandible.

tracing A line or lines, scribed by a pointed instrument, representing a record of movements of the mandible.

- **extraoral t.** A tracing made outside the oral cavity.
- **intraoral t.** A tracing made within the oral cavity.
- **needle point t., stylus t., Gothic arch t., arrow point t.** A tracing which resembles an arrowhead or a Gothic arch made by means of a device attached to the opposing arches. The shape of the tracing depends upon the relative location of the marking point and the tracing table. The apex of a properly made tracing is considered to indicate the most retruded unstrained relation of the mandible to the maxillae, i.e., centric relation.

transfer coping (See *coping*)

translatory movement The motion of a body at any instant when all points within the body are moving at the same velocity and in the same direction.

trauma 1. A hurt; a wound; an injury; damage; impairment; external violence producing bodily injury or degeneration. (D. & D.) 2. An actual alteration of tissue produced by dental dysharmony.

traumatic Of, or pertaining to, or caused by, an injury. (Dor.)

traumatic occlusion (See *occlusion*)

traumatogenic Capable of producing a wound or injury.

traumatogenic occlusion (See *occlusion*)

treatment plan The sequence of procedures planned for the treatment of a patient.

trial denture, trial plate (Obj.) A setup of artificial teeth so fabricated that it may be placed in the patient's mouth to verify esthetics, for the making of records, or for any other operation deemed necessary before the final completion of the denture.

try-in A preliminary insertion of a complete denture wax-up (trial denture), or of a partial denture casting or of a finished restoration to determine the fit, esthetics, maxillomandibular relation, etc.

tube teeth (See *teeth*)

U

undercut 1. That portion of a tooth which lies between the survey line (height of contour) and the gingivae. 2. The contour of a cross section of a residual ridge or dental arch which would prevent the insertion of a denture. 3. The contour of flasking stone which interlocks in such a way as to prevent the separation of the parts.

unstrained jaw relation (See *jaw relation*)

upper impression (See *impression, maxillary*)

V

vacuum mixing A method of mixing a material, such as plaster of Paris, in a vacuum.

vertical dimension A vertical measurement of the face between any two arbitrarily selected points which are conveniently located, one above and one below the mouth, usually in the midline.

- **occlusal v. d.** The vertical dimension of the face when the teeth or occlusion rims are in contact in centric occlusion.
  - **o. v. d. decrease** May result from modification of tooth form by attrition or grinding, drifting of teeth, or, in edentulous patients, by resorption of residual ridges.
  - **o. v. d. increase** May result from modifications of tooth form, tooth position, height of occlusion rims, rebasing or relining, or occlusal splints.

rest v. d. The vertical dimension of the face with the jaws in rest relation.

r. v. d. decrease May or may not accompany a decrease in o.v.d. It may occur without a decrease in o.v.d. in patients with a preponderant activity of the jaw-closing musculature, as in patients with muscular hypertenseness or chronic gumchewers.

r. v. d. increase May or may not accompany an increase in o.v.d. It sometimes occurs after the removal of remaining occlusal contacts, perhaps as a result of the removal of noxious reflex stimuli.

vertical dimension decrease Decreasing the vertical distance between the mandible and the maxillae by modifications of teeth, the positions of teeth or occlusion rims, or through alveolar or residual ridge resorption.

vertical dimension increase Increasing the vertical distance between the mandible and the maxillae by modifications of teeth, the positions of teeth, or occlusion rims.

vertical opening (Obj.) (See *vertical dimension*)

vertical overlap 1. The extension of the upper teeth over the lower teeth in a vertical direction when the opposing posterior teeth are in contact in centric occlusion. 2. The distance teeth lap over their antagonists vertically. This term is used especially for the distance the upper incisal edges drop below the lower ones, but may be used also to describe the vertical relations of opposing cusps. 3. The relationship of the maxillary incisors to the mandibular incisors when the incisal edges pass each other in centric occlusion.

vestibule (of the mouth) That portion of the oral cavity which lies between the teeth and gingivae, or the residual ridges, and the lips and cheeks.

buccal v. The space between the alveolar or residual ridge and the cheek.

labial v. The space between the alveolar or residual ridge and the lips.

vibrating line The imaginary line across the posterior part of the palate marking the division between the movable and immovable tissues.

vulcanite 1. A combination of caoutchouc and sulfur, which hardens in the presence of suitable heat and pressure. 2. An obsolete denture-base material.

vulcanize To produce flexible or hard rubber, as desired, by subjecting caoutchouc, in the presence of sulfur, to heat and high steam pressure in a vulcanizer. (D. & D.)

W

warp Torsional change of shape or outline, such as that which may occur in swaging sheet metal, or in denture material, or in other materials when exposed for long periods to varying temperatures.

wax expansion A method of expanding the wax patterns to compensate for the shrinkage of gold during the casting process.

wax model denture (See *trial denture*)

wax pattern A wax form of a shape which, when invested and burned out, will produce a mold in which the casting is made.

waxing The contouring of a wax pattern or the wax base of a trial denture into the desired form.

waxing up 1. The contouring of a pattern in wax, generally applied to the shaping in wax of the contours of a trial denture.

working bite (Obj.) (See *working occlusion*)

working contacts Contacts of teeth made on the side of the occlusion toward which the mandible has been moved.

working occlusal surface The surface or surfaces of teeth upon which mastication can occur.

working occlusion The occlusal contacts of teeth on the side to which the mandible is moved.

working side The lateral segment of a denture or dentition toward which the mandible is moved.

X

x-ray (See *roentgenogram*)

x-ray picture (Obj.) (See *roentgenogram*)

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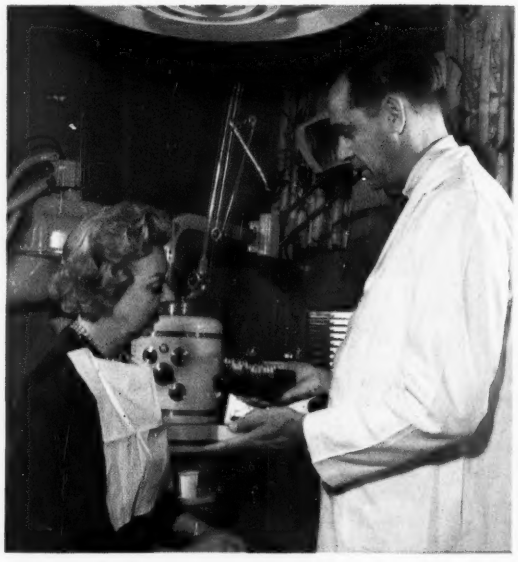

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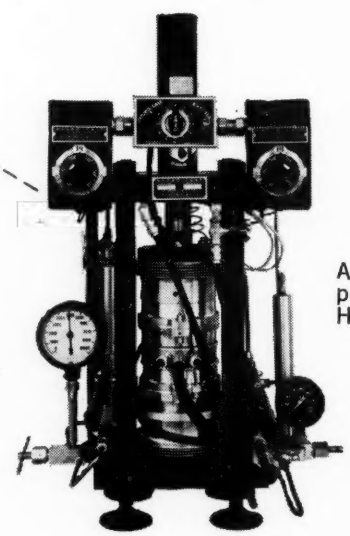

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3207 Washington Blvd.
St. Louis 3, Mo.

Published Bimonthly.
Subscriptions may
begin at any time.

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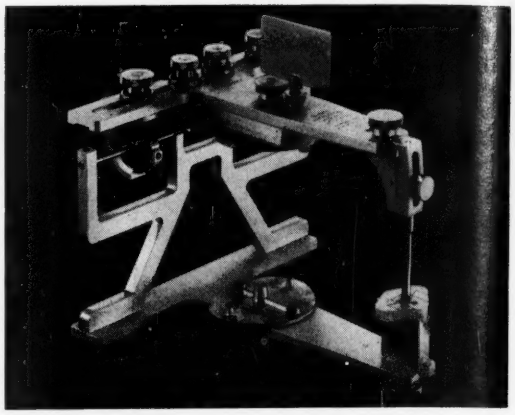

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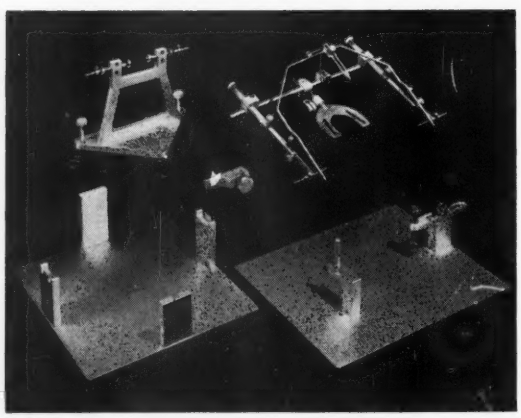

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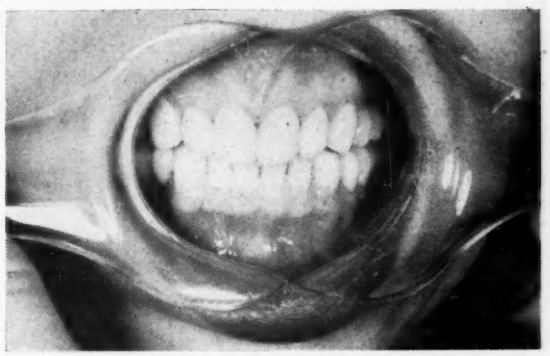

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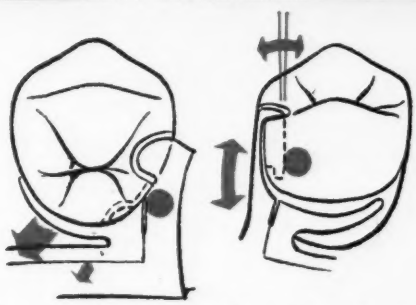

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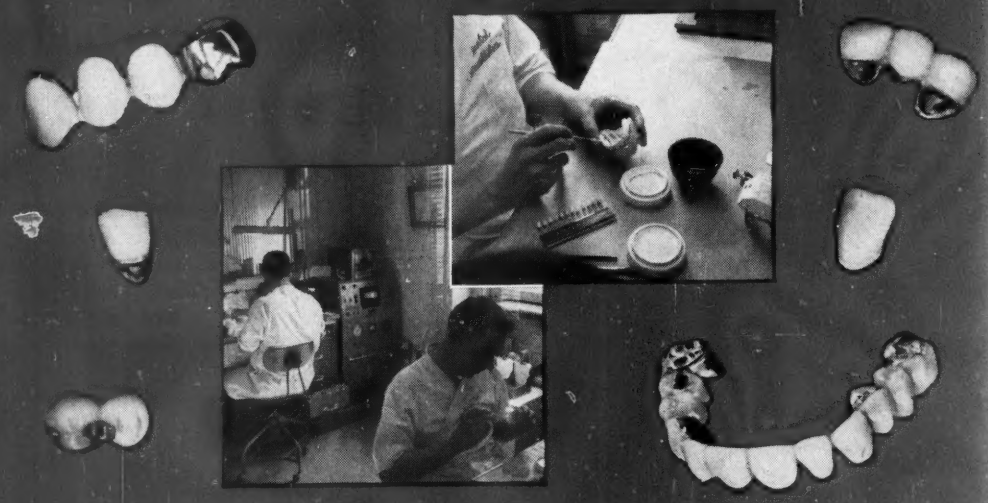

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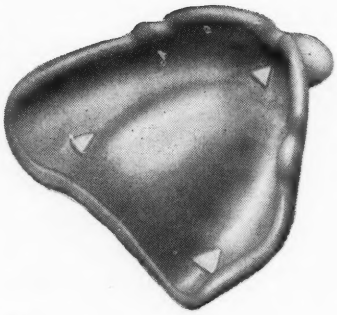

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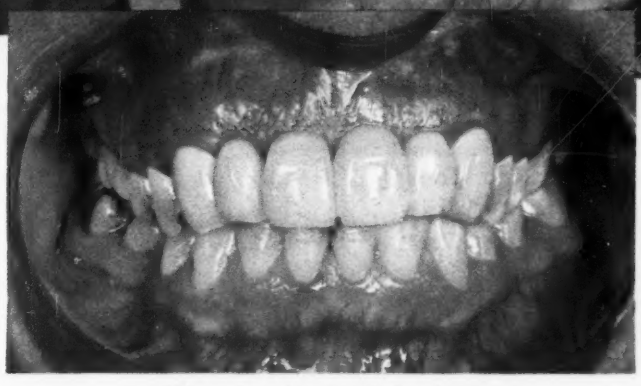

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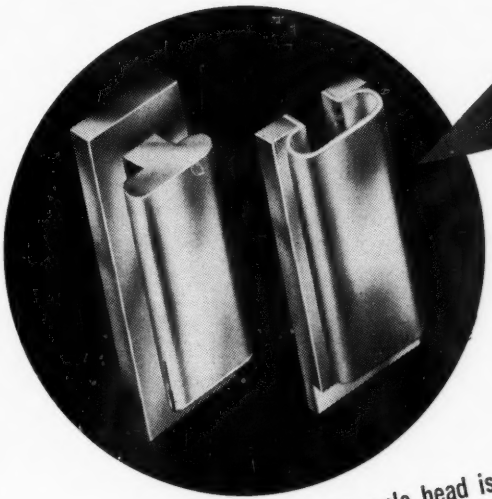

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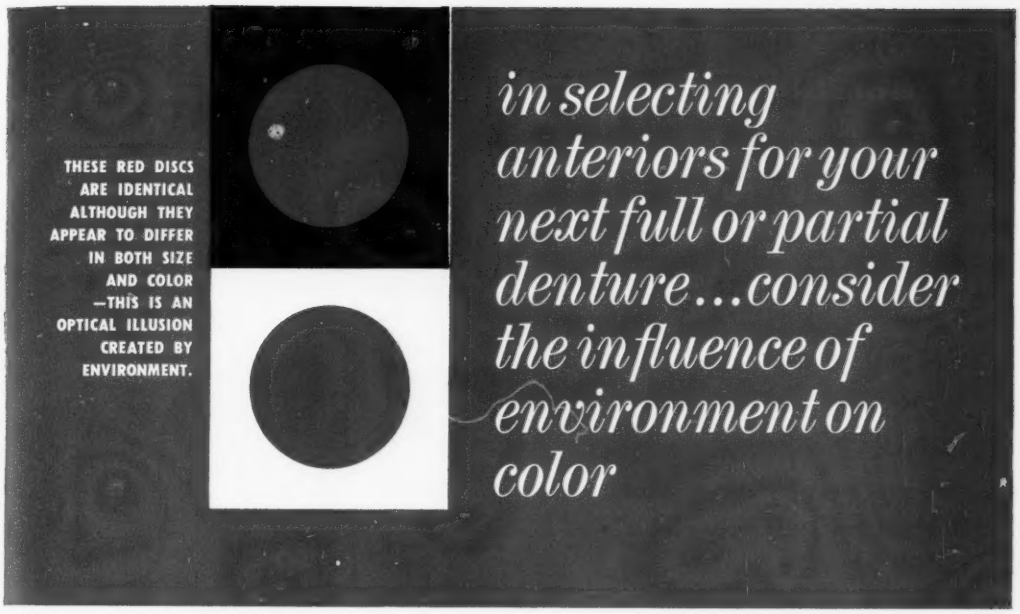
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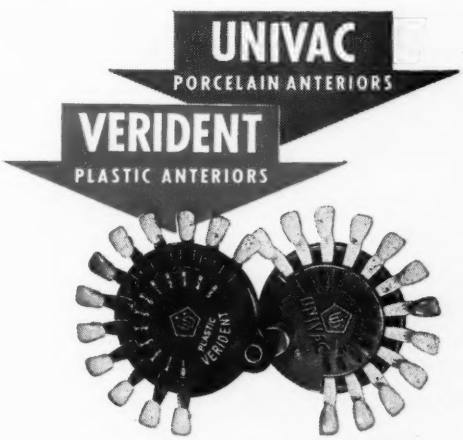

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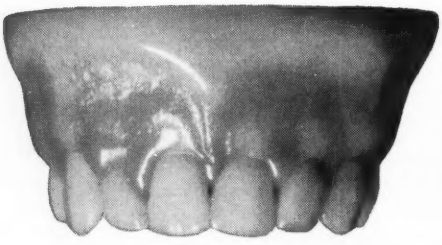

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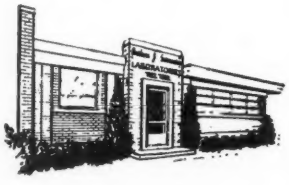

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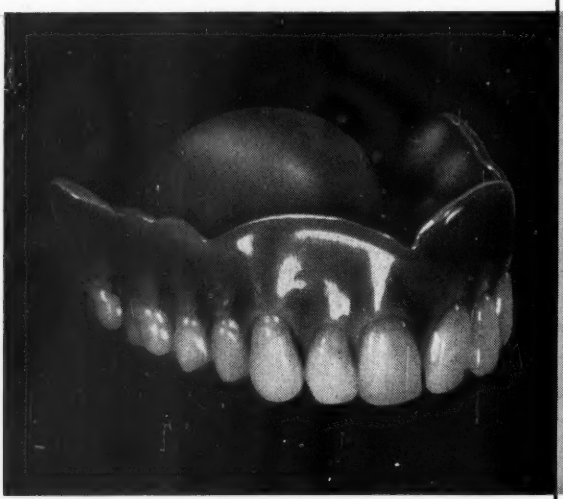

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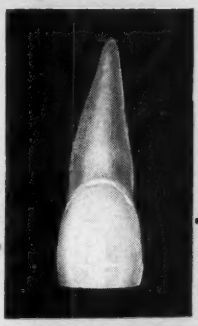

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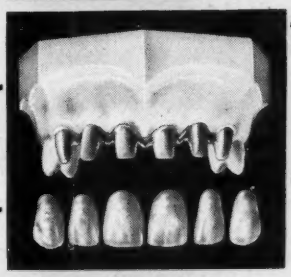

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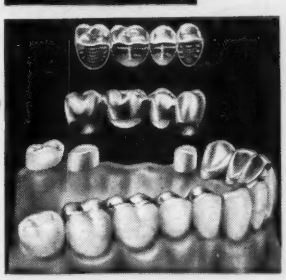

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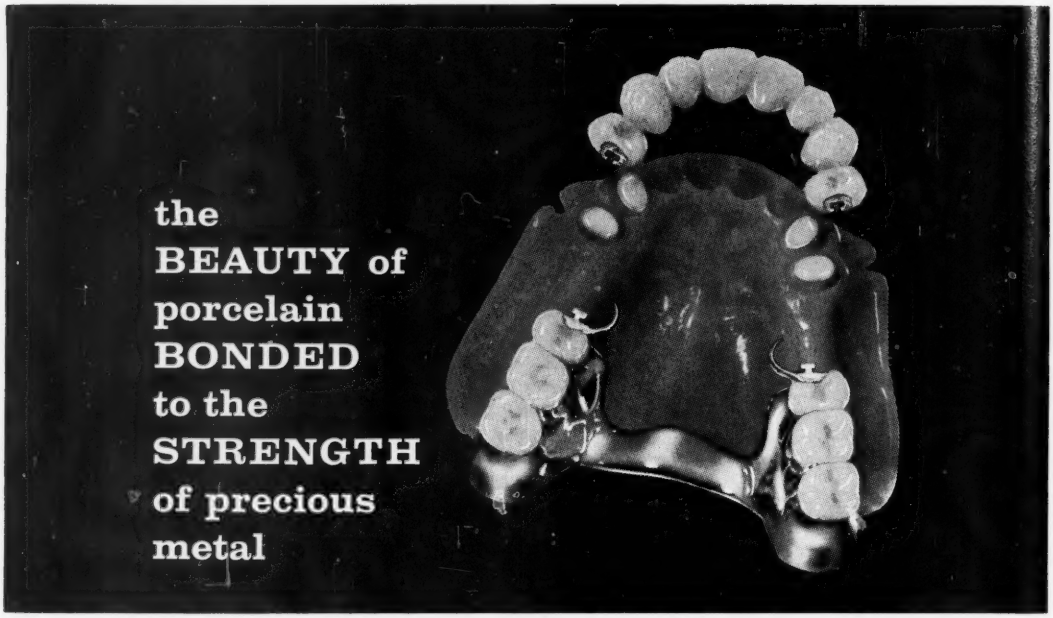

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The importance of contact areas

Mesio distal sections through portions of two bicuspids are used in the drawings to illustrate contact areas and the form of interproximal spaces under certain conditions. The first three drawings illustrate undesirable situations that can cause trouble. The fourth drawing illustrates the ideal type of contact and interproximal space for healthy function.

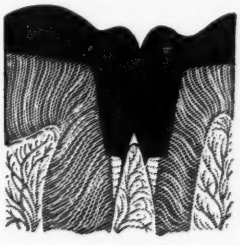

Fig. A: Contact too broad occluso-gingivally.

In Fig. A of the mesio-distal section, for example, the contact is too broad in the occluso-gingival dimension, and stringy foods are apt to be caught and held.

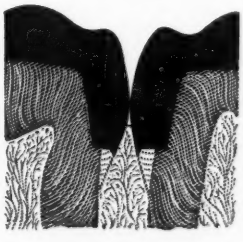

Fig. B: Contact too far to gingival.

In Fig. B the contact is too far to the gingival. This creates a wedge-shaped occlusal embrasure, into which food is packed. The force created destroys the alignment of the teeth damaging the gingival tissues.

Fig. C: Contact too close to occlusal.

Fig. C shows a contact too close to the occlusal. Such a contact does not provide the sluice-way effect so necessary for tissue stimulation and for self-cleansing action.

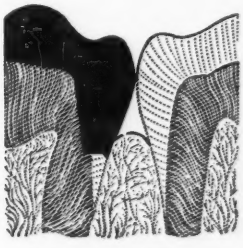

Fig. D: Contact normal.

Fig. D represents the ideal point of contact forming the correct interproximal space. *The J. M. Ney Company, Hartford, 1, Connecticut.*

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(1) Berk, H. and Krakow, A. A., The Alpha Omegan, Vol. LI:95 (Sept.) 1958

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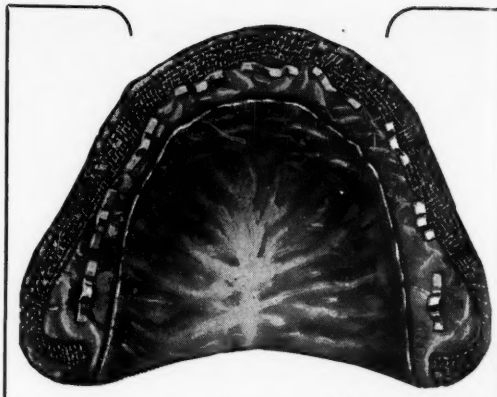

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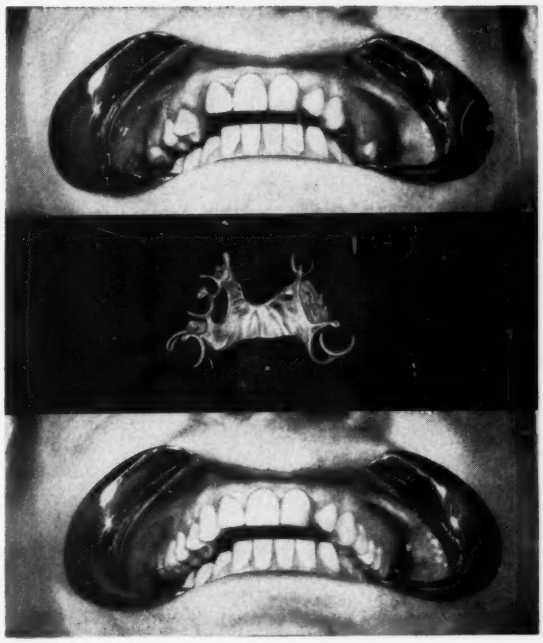

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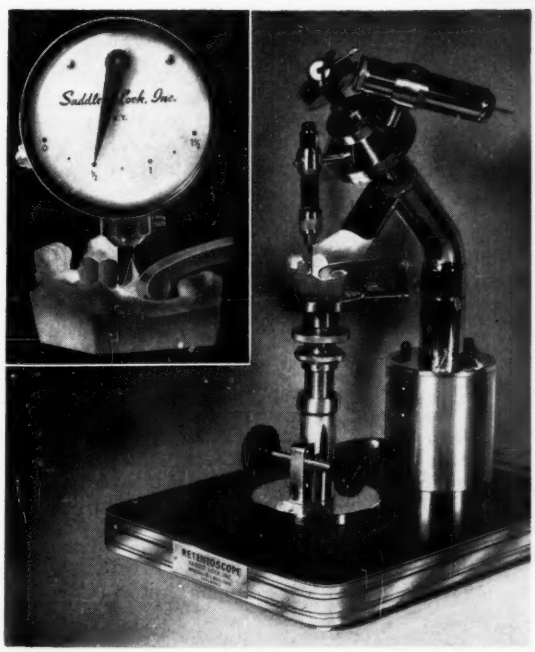

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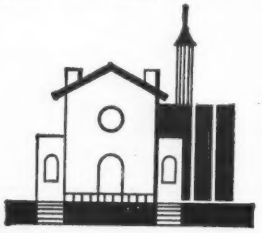

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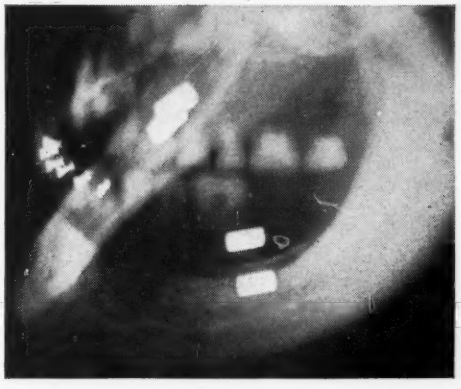

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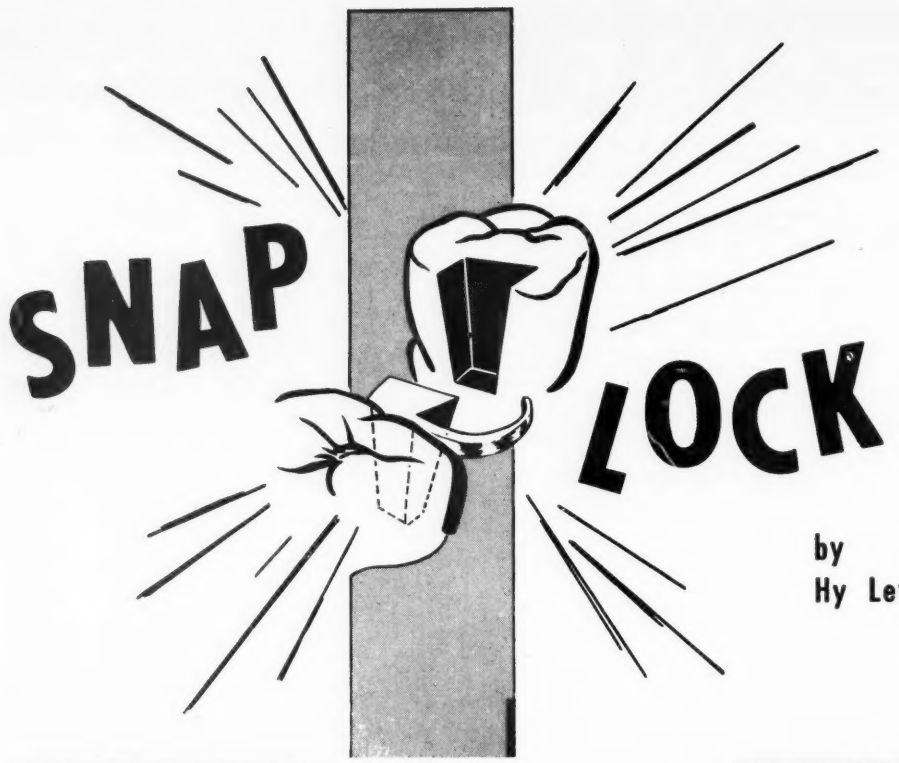

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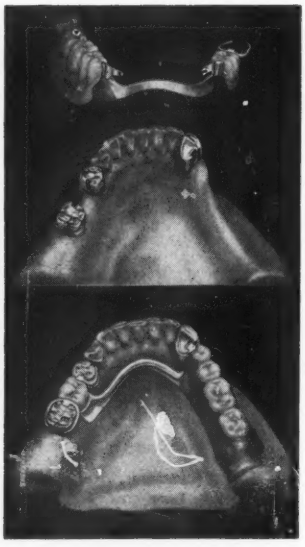

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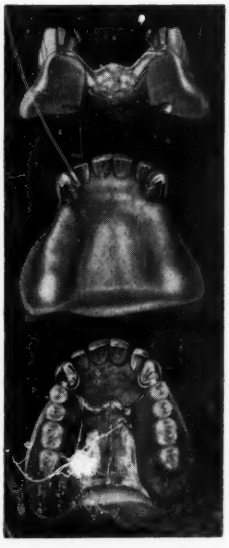

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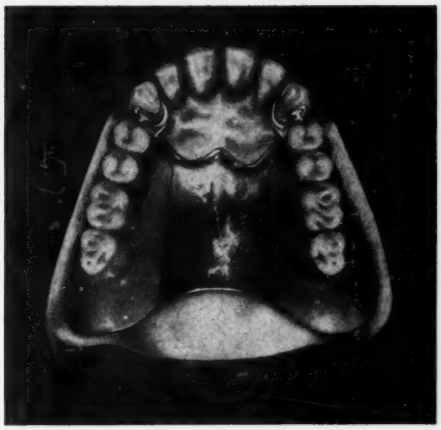

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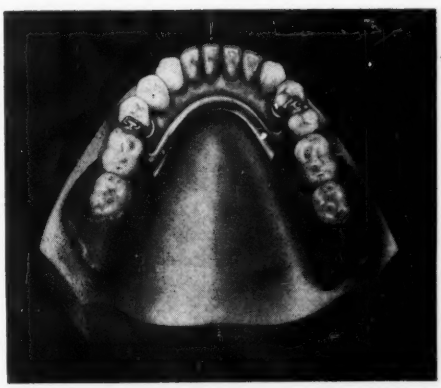

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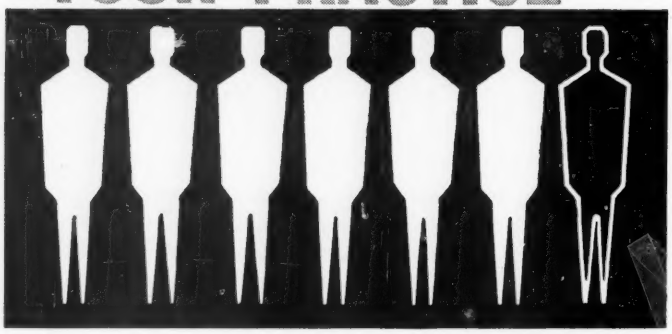

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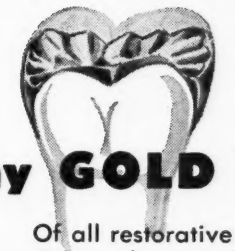

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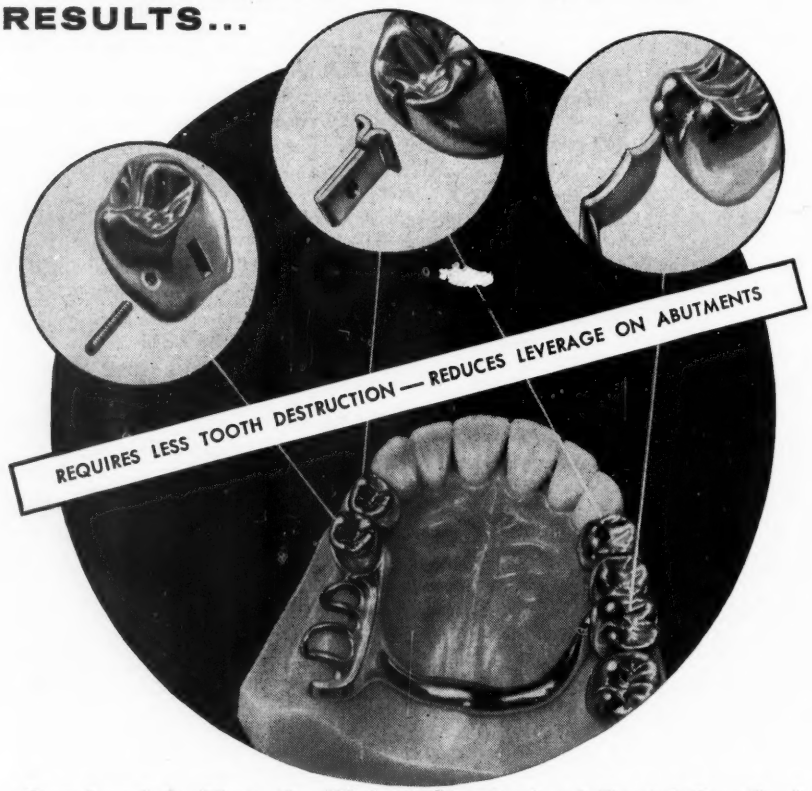

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